

# Project Manual

## Bid Documents

**Jefferson County  
Courthouse and Sheriff's Building  
Renovations and Additions  
Jefferson, Wisconsin**

2020.01.00

July 22, 2022

Volume 2 of 2





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**DIVISION 21**



## SECTION 21 00 10 - FIRE SUPPRESSION GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section applies to all work under the fire suppression contract. This shall include, but not necessarily be limited to, the following:
  - 1. Water Based Fire Suppression Systems
  - 2. Clean Agent Fire Suppression Systems
  - 3. Demolition of Fire Suppression Systems
- B. The work shall include all materials, equipment and labor required for complete and properly functioning fire suppression systems.
- C. Drawings for fire suppression work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

#### 1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
  - 1. International Fire Suppression Code
  - 2. Wisconsin State Plumbing Code
  - 3. International Building Code
  - 4. National Electric Code (NEC)
  - 5. National Fire Protection Association Standards (NFPA)
  - 6. Local Utility Company Requirements
  - 7. Local Codes, all trades
  - 8. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
  - 9. Occupational Safety and Health Administration (OSHA)
  - 10. Underwriters Laboratories, Inc. (U.L.)
  - 11. Wisconsin Administrative Codes

12. Americans With Disabilities Act (ADA)

- B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.
- C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

**1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES**

- A. Contractor shall comply with the rules and regulations of the authorities having jurisdiction and local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Secure all required permits and pay for all inspections, licenses and fees required in connection with the fire suppression work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

**1.5 FIRE SUPPRESSION DRAWINGS**

- A. The fire suppression drawings indicate in general the building arrangement only, Contractor shall examine all construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings for piping are intended to convey the scope of the work and to indicate the general arrangement and locations of piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

**1.6 ACTIVE SERVICES**

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

## **1.7 SITE INSPECTION**

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of the contractor's failure to make this inspection.

## **1.8 COORDINATION AND COOPERATION**

- A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications, or between the requirements set forth for the various contractors, shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the painting contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with General Contractor for patching and refinishing of such areas which may be damaged in this respect.

## **1.9 OPENINGS, CUTTING AND PATCHING**

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe or sleeve shall be sealed with UL listed firestopping material equivalent to rating of wall/floor. Where piping and sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.

- B. New structure:
  - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the fire suppression work with the General Contractor.
  - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
  
- C. Existing Structure:
  - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.
  - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
  - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

#### **1.10 MATERIALS AND EQUIPMENT**

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

#### **1.11 SUBMITTALS**

- A. Contractor shall furnish to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.

E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
21 10 00	Water Based Fire Suppression System	X	X			X	X	1, 2
21 22 00	Clean Agent Fire Extinguishing Systems	X	X			X	X	2

Notes:

1. Hydraulic calculations.
2. All certifications and test results required by NFPA.

F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.

G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

**1.12 OPERATION AND MAINTENANCE MANUALS**

- A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three-ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION  
AND  
MAINTENANCE  
MANUAL  
FOR  
FIRE SUPPRESSION SYSTEMS

(PROJECT NAME)  
(LOCATION)  
(DATE)

SUBMITTED BY  
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
  - 1. Equipment and system warranties and guarantees.
  - 2. Installation instructions.
  - 3. Operating instructions.
  - 4. Maintenance instructions.
  - 5. Spare parts identification and ordering list.
  - 6. Local service organization, address, contract and phone number.
  - 7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
  - 8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

**1.13 TRAINING AND DEMONSTRATIONS**

- A. Prior to acceptance of the fire suppression installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.
  - 1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
  - 2. Prepare the instruction format for a minimum of four Owner Representatives.
- B. Equipment training:
  - 1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.



2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
3. Training shall be performed by qualified factory trained technicians.
4. Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
21 10 00	Water Based Fire Suppression System	4	Contractor		
21 22 00	Clean Agent Systems	4	Manufacturer's Representative	Contractor	
1. Any unused hours shall be used at Owner's discretion during the first year of occupancy.					

D. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to the Owner's satisfaction. An example of a certificate form is as follows:

**CERTIFICATE OF SYSTEM DEMONSTRATION**

This document is to certify that the contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: \_\_\_\_\_

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: \_\_\_\_\_

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

\_\_\_\_\_ signature

\_\_\_\_\_ date

Owner's Representative:

\_\_\_\_\_ signature

\_\_\_\_\_ date

#### **1.14 SUBSTITUTIONS**

- A. Refer to Divisions 00 and 01.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

#### **1.15 ACCEPTABLE MANUFACTURERS**

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

#### **1.16 WARRANTY**

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
  - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
    - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
    - b. The entire Fire Suppression system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 21 sections for systems, equipment, or material requiring extended warranties.

- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

**1.17 COMPLETION**

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

**1.18 CLEANING**

- A. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.

**PART 2 - PRODUCTS (Not Applicable)**

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 21 00 10**

## SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section includes the following:
  - 1. Sleeves
  - 2. Escutcheons
  - 3. Fire Stopping
  - 4. Demolition

### PART 2 - PRODUCTS

#### 2.1 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

#### 2.2 SLEEVES

- A. Sleeves passing through non load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
  - 1. For pipes 2 1/2" and smaller 24 gauge
  - 2. For pipes 3" to 6" 22 gauge
  - 3. For pipes over 6" 20 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.
- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.

- G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal).

### **2.3 ESCUTCHEONS**

- A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around pipe; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve with set screws or other approved devices.

### **2.4 FIRESTOPPING**

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor, pipe, and sleeve, shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor.

## **PART 3 - EXECUTION**

### **3.1 DEMOLITION**

- A. General
  - 1. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
  - 2. Contractor shall remove existing equipment and piping not necessary for additions or existing portions of building as indicated on drawings and/or specified herein. To include all abandoned equipment and piping back to point of origin. Demolition of equipment shall include removal of associated concrete equipment pad and/or support steel.
  - 3. Contractor shall be responsible for the cutting and capping of all existing services before any work is commenced by the General Contractor.
- B. Work by Others: Unless specifically noted under other contracts, Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
  - 1. General Contractor will remove any floors, walls and ceilings, neatly patch, match, complete and finish all affected surfaces.
  - 2. Electrical Contractor will disconnect all electrical services and remove abandoned conduit back to point of origin.
- C. Existing Conditions:
  - 1. If any piping serving existing fixtures or equipment which are to remain are disturbed by operations under this Contract, Contractor shall provide pipe and insulation required to reestablish continuity of such piping systems.
  - 2. Contractor shall arrange for General Contractor to repair, patch and paint all construction, with material necessary to match surrounding material, which is necessary due to removal of equipment and piping.
  - 3. Contractor shall furnish all required labor and material where required to extend new work to connect to similar work where new addition adjoins existing building and for extension of existing system. Connection shall be made in a suitable manner.
- D. Owner's Right of Salvage: The Owner may designate and have salvage rights to any material herein demolished by the Contractor.

**3.2 SLEEVES**

- A. Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

**3.3 ESCUTCHEONS**

- A. Install escutcheons for all pipes entering finished spaces.

**END OF SECTION 21 05 00**

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## **SECTION 21 05 53 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED WORK**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

#### **1.2 DESCRIPTION OF WORK**

- A. Extent of fire suppression identification work required by this section is indicated on drawings and/or specified in other Division 21 sections.
- B. Type of identification devices specified in this section include the following:
  - 1. Painted identification materials
  - 2. Plastic pipe markers
  - 3. Plastic tape
  - 4. Valve tags
- C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division 21 sections.

#### **1.3 QUALITY ASSURANCE**

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

#### **1.4 SUBMITTALS**

- A. Schedules: Submit valve schedule for fire suppression system, typewritten and reproduced on 8 1/2" x 11" bond paper. Tabulate valve number, system or zone (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut off and similar special uses, by special "flags", in margin of schedule. In addition, furnish extra copies for Maintenance Manuals.

### **PART 2 - PRODUCTS**

#### **2.1 IDENTIFICATION MATERIALS**

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 21 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.
- B. Painted Identification Materials:
  - 1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
  - 2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.

3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

C. Plastic Pipe Markers:

1. General: Provide manufacturer's standard preprinted flexible or semi rigid, permanent, color coded, plastic sheet pipe markers, complying with ANSI A13.1.
2. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
  - a. Snap on application of pre tensioned semi rigid plastic pipe marker.
  - b. Adhesive lap joint in pipe marker overlap.
  - c. Laminated or bonded application of pipe marker to pipe (or insulation).
  - d. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1 1/2".
3. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full band or narrow strip type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
  - a. Laminated or bonded application of pipe marker to pipe (or insulation).
  - b. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
  - c. Strapped to pipe (or insulation) application of semi rigid type, with manufacturer's standard stainless steel bands.
4. Lettering: Manufacturer's standard preprinted nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.
5. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

D. Plastic Tape:

1. General: Manufacturer's standard color coded pressure sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
  - a. Width: Provide 1 1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes.
  - b. Color: Comply with ANSI A13.1, except where another color selection is indicated.

E. Valve Tags:

1. Brass Valve Tags: Provide polished brass valve tags with stamp engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
  - a. Provide 2" diameter tags, except as otherwise indicated.
  - b. Fill tag engraving with black enamel.
2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.
3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S hooks or heat sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

- F. Name Plates:
1. General: Provide manufacturer's standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
  2. Lettering:
    - a. Large Equipment: 1 1/2" lettering as appropriate.
    - b. Small Equipment: 3/4" lettering as appropriate.
  3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

## 2.2 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in fire suppression identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of fire suppression systems and equipment.
1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Fire Pump, Standpipe F12).

## PART 3 - EXECUTION

### 3.1 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
1. Coordination: Where identification is to be applied to surfaces which require painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.
- B. Piping System Identification:
1. General: Install pipe markers of one of the following types on all fire suppression piping, and include arrows to show normal direction of flow:
    - a. Stenciled markers, including color coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
    - b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
    - c. Stenciled markers, black or white for best contrast, wherever continuous color coded painting of piping is provided.
  2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non concealed locations.
    - a. Near each valve and control device.
    - b. Near locations where pipes pass through walls or floors/ceilings, or enter non accessible enclosures.
    - c. At access doors, manholes and similar access points which permit view of concealed piping.

- d. Near major equipment items and other points of origination and termination.
- e. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
- f. On piping above removable acoustical ceilings.

C. Valve Identification:

- 1. General: Provide valve tag on every valve, cock and control device in fire suppression piping system; exclude check valves. List each tagged valve in valve schedule for each piping system.

D. Equipment Identification:

- 1. General: Provide equipment identification for all equipment including fire pumps, fire pump controllers, zone control valves, and specialty system valves where applicable (i.e. dry valve or preaction system).
- 2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.
- 3. Provide identification by means of nameplates or stenciled painting as appropriate.
  - a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.

**END OF SECTION 21 05 53**

## SECTION 21 10 00 – WATER-BASED FIRE SUPPRESSION SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 21 00 10 - Fire Suppression General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of fire suppression work is indicated on drawings and schedules, and by requirements of this section.
- B. Applications of fire suppression systems include the following:
  - 1. Sprinkler systems.

#### 1.3 QUALITY ASSURANCE

- A. NFPA Code: Comply with ANSI/NFPA 13, "Installation of Sprinkler Systems", and ANSI/NFPA 24, "Private Fire Service Mains and Their Appurtenances", where applicable.
- B. UL Labeling: Provide fire sprinkler piping products which have been approved and labeled by Underwriters Laboratories.
- C. Local Fire Marshal Regulations: Comply with governing regulations pertaining to fire sprinkler piping.
- D. State Fire Marshal's Office Regulations: Comply with governing regulations pertaining to fire sprinkler piping.
- E. All fire suppression work shall be performed by a qualified sprinkler contractor with at least three years' experience that has obtained current certification in the State of Wisconsin under the Fire Extinguishing System Contractor Certification program. During the installation, a minimum of one person with at least three years sprinkler experience shall be present.
- F. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- G. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data for fire suppression systems, materials and products.
- B. Piping Shop Drawing and Hydraulic Calculations: The Contractor shall prepare a complete set of detailed working drawings and hydraulic calculations showing all equipment, fire service lines, risers, piping and heads. These drawings and calculations shall be approved in writing or stamped approved by the authorities having jurisdiction. Contractor is responsible for any fees associated with the review and approval of the fire suppression layout drawings, product data and hydraulic calculations.

- C. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed
- D. Grooved joint couplings and fittings shall be referred to on drawings and product submittals, and be identified by the manufacturer's listed model or series designation.
- E. Certificate of Installation: Submit certification upon completion of fire suppression piping work which indicates that work has been tested in accordance with ANSI/NFPA 13 and also that system is operational, complete and has no defects.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Fire Suppression Specialties
  - 1. Reliable Sprinkler Corporation.
  - 2. Tyco.
  - 3. Viking Corp.
  - 4. Globe Fire Sprinkler Corporation
  - 5. Victaulic
  - 6. Potter
  - 7. System Sensor
- B. Backflow Preventers
  - 1. Watts
  - 2. Apollo Valves
  - 3. Febco
  - 4. Zurn Wilkins
- C. Gate Valves
  - 1. NIBCO
  - 2. Powell
  - 3. Milwaukee
  - 4. Watts
  - 5. Victaulic
- D. Bronze Body Butterfly Valves
  - 1. NIBCO
  - 2. Milwaukee
- E. Butterfly and Swing Check Valves
  - 1. Victaulic
  - 2. Gruvlok by Anvil International
  - 3. Kennedy
  - 4. Milwaukee
  - 5. NIBCO

- F. Ball Valves
  - 1. Watts B-6000 Series
  - 2. Milwaukee BA-100/BA-150
  - 3. NIBCO T-580 Series
  - 4. Apollo 77C Series
  - 5. Victaulic
  
- G. Grooved Piping Systems
  - 1. Gruvlok by Anvil International
  - 2. Victaulic
  
- H. Fire Department Connections
  - 1. Larsen's Manufacturing Company
  - 2. Guardian Fire Protection Equipment
  - 3. Potter-Roemer
  - 4. Croker

## 2.2 FIRE SUPPRESSION SPECIALTIES

- A. General: Provide fire suppression specialties, UL listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.
  - 1. Water Flow Indicators: Provide vane type water flow detectors.
  - 2. Outdoor Alarm Bell: Provide electric alarm bell in accordance with NFPA 13. Coordinate installation with Electrical Contractor.
  - 3. Supervisory Switches: Provide products recommended by manufacturer for use in service indicated.
  - 4. Automatic Sprinklers:
    - a. Provide automatic sprinklers of type indicated on drawings, and in accordance with the following listing. Provide liquid bulb, ordinary temperature, except where intermediate or high temperature rated sprinklers are required per NFPA 13 or as indicated on the plans.
      - 1) Upright
      - 2) Concealed Pendent with Flat Cover Plate
      - 3) Pendant
      - 4) Standard Dry-Type Pendent
      - 5) Standard Dry-Type Upright
      - 6) Dry-Type Concealed Pendent with Flat Cover Plate
    - b. Finish: Painted white for concealed pendent, cast brass for upright pendent, chrome for recessed pendent or provide finish as indicated on the plans. Where in an area with existing heads, match finish of existing.
  - 5. Sprinkler Cabinet and Wrench: Furnish steel, baked red enameled, sprinkler box with capacity to store 10 sprinklers and wrench sized to sprinklers.
  - 6. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
  - 7. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss cast in the sprinkler body.

### 2.3 CONNECTIONS AND TEST HEADERS

- A. Fire Department Connection: Provide fire department connection with integral clappers, 175 psi rated working pressure, of size and end type indicated.
- B. Provide fire pump test header of size and type indicated. Refer to plans for more information.

### 2.4 BACKFLOW PREVENTERS

- A. **A3.** Double Check Assembly Backflow Preventer (at main sprinkler system supply): A double check assembly shall be installed at referenced cross connections to prevent the backflow of polluted water into the potable water supply. The cross connections shall be determined by local inspection authority for use where a high hazard situation does not exist; it shall be a complete assembly consisting of two independent tri-link check modules within a single housing, sleeve access port, four test cocks and two drip tight shut-off valves. Checks shall be removable and serviceable, without use of special tools. 304 Schedule 40 stainless steel pipe with groove end connections. Assembly shall be Watts Regulator Co. Series 757 or 757N. The device shall meet the requirements of ANSI/ASSE Standard 1015 and AWWA Standard C510-92 and be approved by the FCCCHR at USC. All components of the backflow preventer assembly shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

### 2.5 VALVES

- A. Butterfly - 1/4" to 2" Milwaukee Butterball BB2 Series
- B. Ball - 2" to 3" Victaulic Series 727
- C. Butterfly - 4" to 8" Victaulic Series 705 (Normally Open Valves) or Series 707C (Normally Closed Valves)
- D. Gate - 2-1/2" and larger, iron body O.S.&Y., Powell Fig. 1797
- E. Check - 2-1/2" to 3", Central Model 90, 4" to 8" Victaulic Series 717
- F. Zone Control valve with Check Assembly – 1 1/4" – 8" Victaulic Model Globe UMC

### 2.6 PIPE MATERIALS

	<u>Material</u>	<u>Service</u>
	Ductile iron pipe ANSI A21.5 ANSI/AWWA C151.	Underground water service main, 4" dia. and larger, above ground water service main up to inlet of fire pump or backflow preventer
A.	Polyvinyl Chloride Pipe (PVC) DR18 ANSI/AWWA C900 or C905 With tracer wire	Underground water service main.
B.	Black steel pipe, Schedule 40, ASTM A795	Wet systems.
C.	Black steel pipe, Schedule 10, ASTM A795	Wet systems.



## 2.7 PIPE FITTINGS

### A. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Malleable or Ductile iron fittings, 150 pound standard flat band water pattern.
2. Welded pipe (2 1/2" dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.
3. Mechanical grooved and roll-groove steel piping system and fittings: may be used as approved by code for black steel, stainless steel and galvanized steel. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.
  - a. In lieu of groove type couplings and fittings, Victaulic Installation-Ready™ fittings for Schedule [40] [10] grooved end steel piping in fire protection applications sizes NPS 1-1/4" thru 2 1/2", consisting of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, prelubricated Grade "E" EPDM Type 'A' gasket, and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
  - b. Grooved joint fittings shall be ductile iron conforming to ASTM A-536 Grade 65-45-12, short-pattern with flow equal to standard pattern fittings. Basis of Design: Victaulic FireLock.

### B. Flexible, Sprinkler Hose Fittings:

1. In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
2. The drop shall include a UL approved Series AH1 with 3" bend radius; AH2 or AH2-CC braided hose with a bend radius to 2" to allow for proper installation in confined spaces.
3. Union joints shall be provided for ease of installation.
4. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 or AB2 bracket. The bracket shall allow installation before the ceiling tile is in place.
5. The braided drop system is UL listed for sprinkler services to 175 psi (1206 kPa) and FM Approved to 200 psi (1380 kPa).
6. Flexible Sprinkler drop shall be Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System or approved equal.
  - a. In lieu of rigid connections to dry sprinkler heads, a Victaulic VicFlex™ dry sprinkler, Model VS1, may be used. The sprinkler shall provide a vertical or horizontal flexible connection with a bend radius to 2", and allow for up to 4 bends.
  - b. In lieu of rigid pipe offsets or return bends for sprinkler drops in wet systems in cold storage applications, the Victaulic VicFlex™ V33, V36, or V40 Dry Sprinkler with Integral AB6 Assembly may be used.

## 2.8 JOINTS

### A. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore.

2. Welded pipe (2 1/2" dia and larger): Welding shall conform to welding section of ANSI-B31.3 "Code for Power Piping."
3. Mechanical grooved and roll-groove pipe couplings: Grooved couplings may be used as approved by code for black steel and galvanized steel piping. Gasket type to be used shall be appropriate for intended service. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.
  - a. In lieu of groove type couplings and fittings, Victaulic Installation-Ready™ fittings for Schedule [40] [10] grooved end steel piping in fire protection applications sizes NPS 1-1/4" thru 2 1/2", consisting of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, prelubricated Grade "E" EPDM Type 'A' gasket, and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
  - b. Grooved joint fittings shall be ductile iron conforming to ASTM A-536 Grade 65-45-12, short-pattern with flow equal to standard pattern fittings. Basis of Design: Victaulic FireLock.

## 2.9 NIPPLES AND UNIONS

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type. For threaded brass pipe, use bronze ground joint unions with octagon ends.
- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
  1. Long runs, at intervals of 80 feet.
  2. In by-pass around equipment, valves, and controls.
  3. In connections to equipment.
  4. Where indicated on drawings.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Contractor shall familiarize himself with the general construction, plumbing, heating, ventilating, and electrical work and to use the information to avoid conflicts in space allocation with the other trades. Do not place pipes over electrical equipment.
- B. In the case of an interference occurring during construction, Contractor shall rework and reinstall piping and equipment in order to make space available for another contractor's equipment without additional cost to the Owner.
- C. Contractor shall work closely with the ceiling system installers and install sprinkler head drops before ceiling tiles are installed, and return to job after or during ceiling tile installation for installation of sprinkler heads.
- D. Heads shall be located in center of ceiling tiles or as directed by Design Professional.

### 3.2 FIRE SUPPRESSION SPECIALTIES

- A. General: Install fire suppression specialties as indicated, and in accordance with ANSI/NFPA 13.

- B. Provide wire guards for all exposed sprinkler heads installed in gymnasiums, below ductwork in mechanical rooms, in electrical rooms, in telecommunication rooms, and locations where heads are susceptible to mechanical damage (e.g. within seven feet of floor level).

### **3.3 BACKFLOW PREVENTERS**

- A. Install backflow preventers where required per local code and in accordance with manufacturer's recommendations. Backflow preventers to be installed accessible for testing, installing contractor shall provide testing by a certified backflow assembly tester at time of installation as required by Code.

### **3.4 VALVES**

- A. Install valves as indicated on the drawings and as specified herein. Install sectional valves in inlet piping at bottom of each riser and in loops as indicated. Locate valves for easy access and operation. Do not locate valves with stems below horizontal. Mount supervisory switches on each sectional valve.
- B. Install valves in equipment rooms to provide easy access to valve. Each valve installed 8'-0" above the floor shall be provided with chain operator. Bottom of chain operator shall be 7'-0" above floor.
- C. Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.
- D. Normally Open (N.O.) or Normally Closed (N.C.) valves shall be provided as required for intended system operation. For all supervised valves, the off-normal signal shall be initiated during the first two revolutions of the hand wheel or during one-fifth of the travel distance of the valve control apparatus from its normal position.

### **3.5 PIPING**

- A. General: Comply with requirements of ANSI/NFPA 13 for installation of fire sprinkler piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that fire sprinkler piping complies with requirements and serves intended purposes.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other mechanical items. Locate groups of pipes parallel to each other; space at a distance to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage. Install drain piping at low points of fire sprinkler piping.
- D. Install valved hose connections of sizes indicated, or 3/4" size if not otherwise indicated, on sprinkler at ends of branch lines and cross mains at locations where indicated.
- E. Install air vents at high points of sprinkler piping.
- F. Hangers and supports: Comply with NFPA for hanger materials
  - 1. Install sprinkler system piping according to NFPA 13.

- G. Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

### **3.6 ADJUST AND CLEAN**

- A. Sprinkler Piping Flushing: Prior to connecting sprinkler risers for flushing, flush water feed mains, lead-in connections and control portions of sprinkler piping. After fire sprinkler piping installation has been completed and before piping is placed in service, flush entire sprinkler system, as required to remove foreign substances, under pressure as specified in ANSI/NFPA 13. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

### **3.7 FIELD QUALITY CONTROL**

- A. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 2 hours, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.
- B. Repair or replace piping system as required to eliminate leakage in accordance with ANSI/NFPA standards for "little or no leakage", and retest as specified to demonstrate compliance.

### **3.8 EXTRA STOCK**

- A. General: For each style and temperature range required, furnish additional sprinkler heads, amounting to 1 unit for every 100 installed units, but not less than 5 units of each.

**END OF SECTION 21 10 00**

**DIVISION 22**



## SECTION 22 00 10 - PLUMBING GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section applies to all work under the plumbing contract. This shall include, but not necessarily be limited to, the following:
  - 1. Waste and Vent Systems
  - 2. Hot and Cold Water Distribution System
  - 3. Plumbing Fixtures
  - 4. Water Heating Systems
  - 5. Sanitary Sewer
  - 6. Piping Insulation
  - 7. Natural Gas System
- B. The work shall include all materials, equipment and labor required for complete and properly functioning plumbing systems.
- C. Drawings for plumbing work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

#### 1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
  - 1. International Fire Suppression Code
  - 2. International Plumbing Code
  - 3. Wisconsin State Plumbing Code
  - 4. International Plumbing Code
  - 5. National Electric Code (NEC)
  - 6. National Fire Protection Association Standards (NFPA)
  - 7. Local Utility Company Requirements
  - 8. Local Codes, all trades

9. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
10. Occupational Safety and Health Administration (OSHA)
11. Underwriters Laboratories, Inc. (U.L.)
12. Wisconsin Administrative Codes
13. Americans With Disabilities Act (ADA)
14. ANSI/NSF 372

- B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.
- C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

#### **1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES**

- A. Contractor shall comply with the rules and regulations of the authorities having jurisdiction and local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Meters for incoming services shall be selected based on the project requirements. Any questions concerning this shall be referred to Design Professional prior to bidding. Contractor shall provide the appropriate meter and associated materials if not furnished by the utility company.
- C. Secure all required permits and pay for all inspections, licenses and fees required in connection with the plumbing work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.
- D. Contractor shall make all arrangements with each utility company and pay all service charges associated with new service.

#### **1.5 PLUMBING DRAWINGS**

- A. The plumbing drawings indicate in general the building arrangement only, Contractor shall examine construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings are intended to convey the scope of the work and to indicate the general arrangement and locations of piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.



## **1.6 ACTIVE SERVICES**

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

## **1.7 SITE INSPECTION**

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

## **1.8 COORDINATION AND COOPERATION**

- A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.

- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

## **1.9 OPENINGS, CUTTING AND PATCHING**

- A. Piping and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe and/or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping and sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- B. New structure:
  - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the plumbing work with the General Contractor.
  - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
- C. Existing Structure:
  - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.
  - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
  - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

## **1.10 EXCAVATING AND BACKFILLING**

- A. Contractor shall do all excavating necessary for sanitary sewers, storm sewers, water piping, gas piping, etc., and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the pipe. Excavation shall be kept free from water by pumping if necessary.
- B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit and shall be carried to a crown approximately six (6) inches above existing grades. In backfilling trenches, selected material shall be compacted firmly around and to a depth of not less than six (6) inches over the top of work in trench. All fill and backfill and rough grading shall be compacted thoroughly in layers and shall be brought up to within six (6) inches of finished grades. All fill and backfill shall be sand or pit run sand/gravel graded from 1" size downward, if excavated material is not suitable for backfill.

**1.11 MATERIALS AND EQUIPMENT**

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

**1.12 SUBMITTALS**

- A. Contractor shall furnish, to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
22 05 16	Expansion Fittings and Loops for Plumbing Piping		X					
22 05 19	Meters and Gages for Plumbing Piping		X					
22 05 23	General Duty Valves for Plumbing Piping		X					
22 05 48	Vibration Controls for Plumbing Piping and Equipment		X					
22 05 53	Plumbing Identification		X					
22 07 00	Plumbing Insulation		X					
22 11 23	Domestic Water Pumps		X			X	X	
22 14 29	Sump Pumps		X			X		
22 34 00	Fuel-Fired Domestic Water Heaters		X			X	X	

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
22 40 00	Plumbing Fixtures		X			X		
22 47 00	Drinking Fountains and Water Coolers		X			X		

- F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

**1.13 OPERATION AND MAINTENANCE MANUALS**

- A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION  
AND  
MAINTENANCE  
MANUAL  
FOR  
PLUMBING SYSTEMS

(PROJECT NAME)  
(LOCATION)  
(DATE)

SUBMITTED BY  
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
  1. Equipment and system warranties and guarantees.
  2. Installation instructions.
  3. Operating instructions.
  4. Maintenance instructions.
  5. Spare parts identification and ordering list.
  6. Local service organization, address, contract and phone number.
  7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
  8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

**1.14 TESTS AND DEMONSTRATIONS**

- A. Tests Required: Piping shall be tested and proved tight under the following static pressures. Pressure shall be maintained for four (4) hours.

<u>System</u>	<u>Pressure</u>
Domestic Water Piping Systems	Refer to Section 22 11 16 – Domestic Water Piping
Soil, Waste, Storm Drainage Piping Below Grade	10 feet waterhead or fill to top of vent outlet above roof.
Soil, Waste, Storm Drainage Piping Above Grade	Fill piping with water to top of vent outlet above roof, or 10 feet waterhead.
Gas Piping	10 psi air pressure, liquid soap test around all joints.

TESTING NOTE: All rubber gasket joints for cast iron soil pipe and fittings should be properly restrained if test pressures exceed 10 feet of head.

- B. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Contractor shall submit a report to Design Professional citing dates, times, pressures, and results of all tests performed.

**1.15 TRAINING AND DEMONSTRATIONS**

- A. Prior to acceptance of the plumbing installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.

- 1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
- 2. Prepare the instruction format for a minimum of four Owner Representatives.

- B. Equipment training:

- 1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
- 2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
- 3. Training shall be performed by qualified factory trained technicians.
- 4. Plumbing Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
- 5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

- C. System training:

- 1. These sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

D. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
22 00 10	Plumbing System (Excluding Equipment)	8	Contractor		Note 2
22 33 00 22 34 00	Water Heaters	4	Manufacturer's Representative	Contractor	
22 11 23	Plumbing Pumps	2	Manufacturer's Representative	Contractor	
1. Any unused hours shall be used at Owner's discretion during the first year of occupancy. 2. System training shall include, but not be limited to, valve locations, system routing, and air/water flow patterns, system start-up/shut-down/emergency procedures.					

E. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner's satisfaction. An example of a certificate form is as follows:

**CERTIFICATE OF SYSTEM DEMONSTRATION**

This document is to certify that Contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: \_\_\_\_\_

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: \_\_\_\_\_

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

\_\_\_\_\_ Signature

\_\_\_\_\_ date

Owner's Representative:

\_\_\_\_\_ signature

\_\_\_\_\_ date

## **1.16 SUBSTITUTIONS**

- A. To obtain approval to use unspecified equipment, submit written requests to the Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

## **1.17 ACCEPTABLE MANUFACTURERS**

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

## **1.18 WARRANTY**

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
  - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
    - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.



- b. The entire Plumbing system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 22 sections for systems, equipment, or material requiring extended warranties beyond one year.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

#### **1.19 COMPLETION**

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

#### **1.20 CLEANING**

- A. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- C. Before being placed in service, all domestic water distribution systems, including those for cold water and hot water shall be chlorinated as required per Section 22 1116 - Domestic Water Piping.

#### **1.21 ELECTRICAL WORK**

- A. Electrical work and equipment provided by Contractor shall include the following:
  - 1. Starters and disconnects for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
  - 2. Wiring from motors to disconnect switches or junction boxes for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
  - 3. All control wiring in accordance with the requirements of Division 26.
- B. Electrical Contractor shall provide all power wiring for plumbing equipment, including services for motors and equipment furnished by the plumbing contractor. Motor and equipment locations are shown on the electrical drawings.
- C. Electrical Contractor shall make final connections for all motors and equipment furnished by the plumbing contractor.

- D. Electrical Contractor shall furnish safety disconnects and starters for all motors and equipment furnished by the plumbing contractor (unless specifically indicated to be furnished integrally with the equipment), so as to make service complete to each item of equipment.
- E. Contractor shall consult with Electrical Contractor prior to conduit rough-in and shall verify with him the exact locations for rough-ins, and the exact size and characteristics of the services required, and shall provide Electrical Contractor a schedule of electrical loads for the equipment furnished by him. These schedules will be used for sizing services, disconnects, fuses, starters and overload protection.

**1.22 TEMPORARY UTILITIES**

- A. Refer to Division 01 for specific requirements concerning temporary utilities.

**END OF SECTION 22 00 10**

## SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section includes the following:
  - 1. Demolition
  - 2. Sleeves
  - 3. Escutcheons
  - 4. Fire Stopping
  - 5. Guards
  - 6. Access Doors
  - 7. Equipment Pads

### PART 2 - PRODUCTS

#### 2.1 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

#### 2.2 SLEEVES

- A. Sleeves passing through non load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
  - 1. For pipes 2 1/2" and smaller 24 gauge
  - 2. For pipes 3" to 6" 22 gauge
  - 3. For pipes over 6" 20 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.

- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.
- G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal). Waterproofing of pipe penetrations in exterior walls shall be coordinated with waterproofing contractor.

### **2.3 ESCUTCHEONS**

- A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve but not to insulation with set screws or other approved devices.

### **2.4 FIRESTOPPING**

- A. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor.

### **2.5 ACCESS DOORS**

- A. When Plumbing Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, Plumbing Contractor shall notify General Contractor who will provide an access door. Refer to Section 08 3100 – Access Doors and Panels.

## **PART 3 - EXECUTION**

### **3.1 DEMOLITION**

- A. General:
  - 1. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
  - 2. Contractor shall remove existing equipment and piping not necessary for additions or existing portions of building as indicated on drawings and/or specified herein. To include all abandoned equipment and piping back to point of origin. Demolition of equipment shall include removal of associated concrete equipment pad and/or support steel.
  - 3. Contractor shall be responsible for the cutting and capping of all existing services before any work is commenced by the General Contractor.
- B. Work by Others: Unless specifically noted under other contracts, Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:
  - 1. General Contractor will remove any floors, walls and ceilings, neatly patch, match, complete and finish all affected surfaces.
  - 2. Electrical Contractor will disconnect all electrical services and remove abandoned conduit back to point of origin.

- C. Existing Conditions:
1. If any piping serving existing fixtures or equipment which are to remain are disturbed by operations under this Contract, Contractor shall provide pipe and insulation required to reestablish continuity of such piping systems.
  2. Contractor shall arrange for General Contractor to repair, patch and paint all construction, with material necessary to match surrounding material, which is necessary due to removal of equipment and piping.
  3. Contractor shall furnish all required labor and material where required to extend new work to connect to similar work where new addition adjoins existing building and for extension of existing system. Connection shall be made in a suitable manner.
- D. Owner's Right of Salvage: The Owner may designate and have salvage rights to any material herein demolished by the Contractor.

### **3.2 SLEEVES**

- A. Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

### **3.3 ESCUTCHEONS**

- A. Install escutcheons for all pipes entering finished spaces.

### **3.4 GUARDS**

- A. Where exposed insulated piping extends to floor, provide sheet metal guard around insulation to extend up from floor 48". Guard to be galvanized sheet not less than 26 gauge.

### **3.5 CONCRETE EQUIPMENT PADS**

- A. Provide equipment housekeeping pads for all floor mounted equipment. Anchor equipment to concrete equipment pads according to equipment manufacturer's recommendations.
1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in both directions than supported unit. Pads to be a minimum of 4" in height unless noted otherwise.
  2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Install anchor bolts according to manufacturer's recommendations and to elevations required for proper attachment to supported equipment.
  6. Use 3000-psi compressive strength concrete with #3 rebar 12" O.C.

**END OF SECTION 22 05 00**

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## **SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 GENERAL**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### **1.2 DESCRIPTION OF WORK**

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### **1.3 SUBMITTALS**

- A. Submit for all motors provided.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL**

- A. Comply with NEMA MG1 unless noted otherwise.
- B. Constant Speed Motors: Minimum 1.15 service factor; rated at 40 deg. C. ambient temperature with 90 deg. C. temperature rise (Class B insulation).
- C. Motors Used with Variable Frequency Controllers: Inverter duty rated, Class F insulation (minimum). Windings shall be copper magnet with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
- D. Multiple speed motors: Multiple windings.
- E. Motor Efficiency: Premium efficiency as defined in NEMA MG1.
- F. All motors shall be provided as required for motor orientation within equipment.
- G. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulations.

- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.
- I. Motor Enclosures:
  - 1. Shall be the NEMA types shown on the drawings for the motors.
  - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed. Motors located outdoors to be totally enclosed weatherproof epoxy-sealed type.
  - 3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- J. Additional requirements for specific motors, as indicated in other sections, shall also apply.

## **2.2 SINGLE PHASE POWER**

- A. Capacitor start motors starting torque shall be three times full load torque and starting current shall be less than five times full load current.
- B. Pull-up Torque: Up to 350 percent of full load torque.
- C. Breakdown Torque: Approximately 250 percent of full load torque.
- D. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

## **2.3 THREE PHASE POWER - SQUIRREL CAGE MOTORS**

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.



- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 22 05 13**

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## SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install expansion joints and pump connections as required by the drawings and this section.
- B. Any expansion indicated per plans has been based on copper pipe. If Contractor should choose to use an alternate approved material, he shall be responsible for any resulting changes in expansion.

#### 1.3 SUBMITTALS

- A. Submit manufacturer's catalog cuts and schedules for all mechanical joints and pump connectors.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Expansion Compensation Products
  - 1. Flexonics
  - 2. Metraflex
  - 3. Victaulic
  - 4. Minnesota Flexible
  - 5. Keflex
  - 6. Twin City Hose
  - 7. Tri-State Industries
  - 8. Mason Industries

#### 2.2 WATER MAINS

- A. Mechanical Expansion Compensator for 2" diameter and smaller copper pipe: Externally pressurized, all bronze with either stainless steel or bronze bellows, brass or copper shroud and end fittings, internal guides and internal anti-torque device. 150 psi minimum design pressure. Metraflex Model HPFF.
- B. Mechanical Expansion joint for 2-1/2" diameter and larger: Self equalizing, ring controlled bellows, stainless steel shroud and end fittings, internal guides and internal anti-torque device. 300 psi design temperature. Metraflex Model MC.
- C. Pipe Guides: Pre-insulated alignment guides, Keflex series CP.

## **2.3 PUMP CONNECTORS**

- A. Pump Connectors to be braided type, corrugated hose with stainless steel, Metraflex Metra-Mini Series.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Provide for taking up expansion in hot water mains and risers by means of installing loops, bends and mechanical expansion joints.
- B. Use swing or swivel joints for connections from mains to risers and from risers to coils and equipment connections. Cold spring pipe during installation at points of bends or offsets.
- C. Install anchoring as required for controlling expansion. Structural members for anchoring shall be firmly embedded or fastened into building members and shall withstand force of pipe expansion without straining building structure.
- D. Where expansion joints and/or loops are installed, piping shall be properly guided and anchored as recommended by expansion joint manufacturer.
- E. Install pump connectors in suction and discharge lines for each base mounted pump. Pump connectors to be installed in straight line without offset.

**END OF SECTION 22 05 16**

## SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install meters and gauges as required by the drawings and this section.

#### 1.3 SUBMITTALS

- A. Submit manufacturer's catalog cuts showing complete descriptive data.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Thermometers
  - 1. Weiss 9VU35 with lead free thermowell (Base Specification)
  - 2. Taylor
  - 3. Weksler
  - 4. U.S. Gauge
  - 5. Trerice
- B. Gauges (For Water)
  - 1. Weiss Series 4CTS (Base Specification)
  - 2. Dwyer
  - 3. Taylor
  - 4. Weksler
  - 5. U.S. Gauge
  - 6. Trerice

#### 2.2 THERMOMETERS

- A. 9" "Adjust-Angle" industrial thermometer, complete with double thick glass front, red reading, separable socket and arranged so the unit can be set at any required angle front to back or left to right during or after installation. Range 30-180 deg. F for domestic hot water.

#### 2.3 GAUGES

- A. Weiss Series 4" liquid filled compound pressure-vacuum gauge with snubber, stainless steel case, white dial, 1/4" male NPT, lead free brass and solder connection. Range 30" vacuum to 100 lb. pressure for water. Note: For outside applications use silicon filled gauge.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install thermometers in discharge and return piping at water heaters and at other points as indicated on the drawings.
- B. Provide a 1/4" ball valve upstream of all gauges.
- C. Install gauge for each pump, mounted on 1/4" copper tube pipe manifold connected to the suction and discharge of the pump, with ball valves in the manifold on each side of the gauge, so that the gauge may be opened to either the suction or discharge pressure.
- D. Install gauges at pressure reducing valves and at other points as indicated on drawings.

**END OF SECTION 22 05 19**

## SECTION 22 05 23 - GENERAL DUTY VALVES FOR PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 0010 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install valves as required by the drawings and this section.

#### 1.3 SUBMITTALS

- A. Submittal data shall include physical dimensions, construction materials, and pressure and temperature ratings.

#### 1.4 QUALITY ASSURANCE

- A. ANSI/NSF 372 Certification: All potable water supply piping valves (excluding main gate valves greater than 2”) shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Check Valves
  - 1. NIBCO
  - 2. Powell
  - 3. Milwaukee
  - 4. Watts
  - 5. Clow
- B. Lugged Body Butterfly Valves
  - 1. NIBCO
  - 2. ABZ
  - 3. Milwaukee
  - 4. Watts
- C. Ball Valves
  - 1. Watts LFB-6080/6081
  - 2. Milwaukee UPBA-400S/450S
  - 3. NIBCO T/S-585-66 LF
  - 4. Apollo 77CLF-140/240

- D. Domestic Hot Water Recirculation Balancing Valves
1. Taco
  2. Bell & Gossett
  3. Wheatley
  4. Armstrong
  5. Flow Design Inc. (Flow Set)
  6. Griswold
  7. NIBCO
- E. All valves of same type shall be of the same manufacturer unless otherwise specified in this section or on the drawings.
- F. Model numbers in valve schedule based on NIBCO, unless noted otherwise.

## 2.2 VALVE CONSTRUCTION

- A. Check Valves: 2" and smaller, horizontal swing type with Teflon seat, bronze lead free body. 200 psi, CWP and 300 deg. F maximum temperature. 2-1/2" and larger, flanged silent check type with bronze mounted bolted bonnet and renewable seat and disc, ductile iron body, 150 psi at 366 deg F conforming to MSS SP-136.
- B. Ball Valves 4" and smaller: Bronze or brass two-piece with stainless steel ball, teflon seats and stuffing box ring, vinyl insulated lever handle.
1. Full port for valves 2-1/2" and smaller.
  2. Standard port for valves 3" and larger.
- C. Domestic hot water recirculation balancing valves: Bell & Gossett Model CB "Circuit Setter" or equal.
1. Ball type valve with brass body and stainless-steel ball construction, glass and carbon fitted TFE seat rings, extended readout ports with integral check valves and gasketed caps, drain port, calibrated nameplate and position indicator, memory stops, and NPT connectors, rated for 300 psig at 250°F.
  2. Valves to seal leak-tight at maximum rated working pressure.
  3. Valves to be selected for 5 ft. pressure drop at full open setting and design water flow.
- D. Butterfly Valves 3" and Larger: ASTM A536 ductile iron body with aluminum bronze disc, EPDM or BUNA N seat, 416 stainless steel stem with extended neck.

## 2.3 VALVE SCHEDULE

- A. Furnish valves as per the following schedule:

<u>Service</u>	<u>Valve type</u>
Domestic hot and cold-water pressures up to 200 psi	Ball - 2-1/2" and smaller, S-FP600A-LF Ball - 3" and 4", T-FP600A-LF Butterfly – 3" and larger, LD-2000 Check - 2" and smaller, T/S413Y-LF 2-1/2" and larger, 910-LF
Domestic hot water recirculation valves	All sizes – Bell & Gossett Model CB circuit setter.

- B. Valves installed on all systems with insulated piping shall be provided with valve handle extensions and/or extended neck design to facilitate installation of insulation and make handles operable without damage to the insulation.



## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install valves in accessible location in general locations indicated on the drawings and as called for in other sections.
- B. Install valves in equipment rooms to provide easy access to valve. Each valve installed 8'-0" above the floor shall be provided with chain operator. Bottom of chain operator shall be 7'-0" above floor.
- C. Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.

**END OF SECTION 22 05 23**

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## **SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED WORK**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

#### **1.2 DESCRIPTION OF WORK**

- A. Provide materials, equipment, labor and supervision necessary to install hangers, supports, anchors, guides and seals as required by the drawings and this section.
- B. Types of supports, anchors and seals specified in this section include the following:
  - 1. Horizontal Piping Hangers and Supports.
  - 2. Vertical Piping Clamps.
  - 3. Hanger Rod Attachments.
  - 4. Building Attachments.
  - 5. Saddles and Shields.
  - 6. Miscellaneous Materials.
  - 7. Anchors.

#### **1.3 QUALITY ASSURANCE**

- A. Code Compliance: Comply with applicable plumbing and mechanical codes pertaining to product materials and installation of supports, anchors and seals.
- B. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.
- C. ANSI Compliance: All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0 except as supplemented or modified by the requirements of this specification.

### **PART 2 - PRODUCTS**

#### **2.1 HANGERS, SUPPORTS AND ACCESSORIES (Reference Catalog Figure numbers from Anvil)**

- A. Pipe support systems shall secure pipes in place, prevent pipe vibration, provide vertical adjustment for maintaining required grades, and provide for expansion and contraction.
- B. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- C. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.
- D. Wherever possible, structural attachments shall be beam clamps.
- E. All rigid hangers shall provide a means of vertical adjustment after erection.

- F. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- G. Where horizontal piping movements are greater than 1/2 inch, or where the hanger rod angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger pipe and structural attachments shall be offset in such manner that the rod is vertical in the hot position.
- H. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- I. Where supports are attached to concrete or other structural members, care shall be taken to prevent damage or weakening of the structural members.
- J. Where concrete inserts are used, it shall be the Contractor's responsibility to accurately locate and attach inserts to concrete forms.
- K. Hangers and supports that are in direct contact with copper piping shall be copper plated or have nonmetallic coating for electrolytic protection.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION HORIZONTAL PIPE SUPPORT**

- A. Steel and stainless-steel pipe shall be supported at a maximum span of 10 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight.
- B. Copper pipe shall be supported at a maximum length of 6 feet for pipe sizes up through 1-1/2" and at a maximum length of 10 feet for pipe sizes 2" and larger with hanger rods sized accordingly for the total supported weight.
- C. PVC and CPVC pipe shall be supported at a maximum span of 3 feet for pipe sizes up through 1" and at a maximum span of 4 feet for pipe sizes 1-1/4" and larger with hanger rods sized accordingly for total supported weight.
- D. PEX tubing and Polyethylene pipe shall be supported at a maximum span of 32" with hanger rods sized accordingly for the total supported weight.
- E. Cast Iron soil pipe shall be supported with one hanger for each section of pipe (maximum 10' span) with hanger rods sized accordingly for the total supported weight. Locate hangers within 18" of hub or joint.
- F. In addition to the above specified spacings, install additional hangers at change in pipe direction and at concentrated loads, large valves, strainers, etc.
- G. When two or more pipes are to be run parallel together, they may be supported on trapeze type hangers. Trapeze bar angles or channels and hanger rods shall be of sufficient size with required spacing to support the particular group of pipes.
- H. For suspending hanger rods from brackets attached to walls; use welded steel brackets, Fig 194 for loads up to 750 lbs; Fig. 195 for loads up to 1,500 lbs; Fig. 199 for loads up to 3000 lbs.
- I. Where pipes are to be racked along walls, use malleable iron one hole clamp, Fig. 126 for pipes up to 3". For pipes larger than 3", use steel channel strut pipe rack.

- J. Where pipes are to be supported from floor, use unistrut pipe stand with post base. Unformed concrete will not be permitted.
- K. Hangers and supports for insulated cold piping shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, (Fig. 167) in conjunction with hanger or roll device

### **3.2 INSTALLATION VERTICAL PIPE SUPPORTS**

- A. Support vertical steel and copper pipe at every other floor line.
- B. Support vertical cast iron soil pipe at every floor line.
- C. In addition to the above, support vertical pipes at base of riser with base fitting set on concrete or block pier, or by hanger located on horizontal connection close to riser.
- D. Where pipe sleeves extend above floor, place pipe clamps at ceiling below and support clamp extensions from inserts or other approved attachment.

### **3.3 PIPE ATTACHMENTS**

- A. For horizontal steel pipe, use adjustable carbon steel clevis, Fig. 260, for pipes up to 30".
- B. For horizontal copper pipe and tube, use copper plated adjustable carbon steel clevis, Fig. CT 65.
- C. When thermal expansion for horizontal pipe is in excess of 1/2" axially as indicated on the drawing, use adjustable steel yoke pipe roll, Fig. 181, or pipe roll stand, Fig. 177.

### **3.4 INTERMEDIATE ATTACHMENTS**

- A. Hanger rods: use carbon steel single or double end threaded, Figs. 140 and 253 as required. Continuous threaded rod, Fig. 146, may be used wherever possible. Contractor may at his option cut and thread rod on the job site.
- B. Chain, wire or perforated strap hangers will not be permitted. One pipe shall not be suspended from another pipe.
- C. Hangers shall be supported from appropriate structural members. In no case shall hangers be supported from ductwork, cable trays, piping, or other equipment. Existing hangers and supports shall not be used as supports for new hangers unless specifically designed as such, or additional loadings have been confirmed to be acceptable for existing supports.

### **3.5 STRUCTURAL ATTACHMENTS**

- A. For attaching steel or copper plated hanger rods to reinforced concrete; use black carbon steel concrete inserts, Fig. 285 for loads up to 400 lbs., Fig. 281 for loads up to 1200 lbs. or suitable drilled inserts equal to Ramset/Red Head - Trubolt wedge anchor, Ramset/Red Head Epcon system or Hilti Kwik Bolt II anchor.
- B. For attaching steel hanger rods to structural steel beams, use malleable iron C clamps, Fig. 87, with retaining clip for loads up to 500 lbs.; Fig. 229 with extension piece for loads up to 1,365 lbs. For copper plated hanger rods, use copper plated malleable iron C clamps, Fig. CT 88, with hardened cup point set screw, for loads up to 400 lbs.

- C. For attaching steel hanger rods to wood structural members, use malleable iron ceiling flange pipe threaded, Fig. 128 for loads up to 480 lbs., Fig. 153 for loads up to 1270 lbs. For copper plated hanger rods, use copper plated malleable iron ceiling flange, Fig. CT 128R for loads up to 180 lbs.
- D. Under no circumstances shall hangers be attached to metal roof deck.

**3.6 PIPE COVERING PROTECTION**

- A. Hangers and supports for insulated cold piping and ductwork shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, Fig. 160, 161, 162, 163, 164, 165, 165A, 166A, or 167 in conjunction with hanger or roll device.

**3.7 ROOF MOUNTED PIPING AND EQUIPMENT**

- A. Roof mounted equipment, not specified to be mounted on roof curbs, shall be installed on equipment mounting rails specifically designed for that purpose or as shown on plans.
- B. Roof mounted piping shall be mounted on a pipe support system equal to B-Line C-Port.

**END OF SECTION 22 05 29**

## **SECTION 22 05 48 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED WORK**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Conditions are applicable to work required of this section.

#### **1.2 DESCRIPTION OF WORK**

- A. Extent of vibration isolation work required by this section is indicated on drawings and schedules, and/or specified in other Division-22 sections.
- B. All plumbing equipment over one horsepower, unless otherwise noted shall be isolated from the structure by means of vibration and noise isolators.
- C. Where isolator type and deflection are not shown, the related equipment shall be isolated in accordance with the 2011 ASHRAE Handbook - HVAC Applications, Chapter 48.
- D. Types of vibration isolation products specified in this section include the following:
  - 1. Precompressed Molded Fiberglass Isolators.
  - 2. Elastomeric Isolators.
  - 3. Spring Isolators, Free Standing.
  - 4. Isolation Hangers.
  - 5. Flexible Pipe Connectors.
- E. Vibration isolation products furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division-22 sections.
- F. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

#### **1.3 QUALITY ASSURANCE**

- A. Product Qualification: Provide each type of vibration isolation unit produced by specialized manufacturer, with not less than 5 years' successful experience in production of units similar to those required for project.
  - 1. The materials and systems specified in this Section shall all be provided by the Contractor, from a single vibration isolation materials manufacturer to assure single responsibility for the performance of all isolation materials.

#### **1.4 SUBMITTALS**

- A. The isolator manufacturer's submittal shall include the complete design for required isolation and bases, and a tabulation of the design data including O.D., free and operating heights of the isolators.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Vibration Isolation Products
  - 1. Kinetics Noise Control, Inc.
  - 2. Vibration Eliminator Co., Inc.
  - 3. Vibration Mountings and Controls, Inc.
  - 4. Mason Industries
  
- B. Flexible Pipe Connectors
  - 1. Keflex
  - 2. Metraflex
  - 3. Twin City Hose
  - 4. Minnesota Flexible
  - 5. Mason Industries
  
- C. The following item specifications apply to the corresponding Type numbers used in the Vibration Isolation Schedule. Model types are based on the 2011 ASHRAE Handbook - HVAC Applications, Chapter 48.

### **2.2 ISOLATION MATERIALS AND SUPPORT UNITS**

- A. Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have  $k_x/k_y$  ratios of at least 0.9. All springs shall be fully color-coded to indicate capacity – color striping is not considered adequate.
  
- B. Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule.
  
- C. Base Types
  - 1. Type A Bases - no base required. Isolators may be attached directly to the supported equipment.
  - 2. Type B Bases - Steel Equipment Bases: Bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.
  - 3. Vibration bases for fans shall have adjustable motor slide rails as indicated on their Schedule, and shall accommodate motor overhang.
  - 4. Minimum clearance under steel equipment bases shall be 25mm (1”).
  - 5. Type C Bases - Concrete Inertia Bases: Inertia bases shall be of welded steel construction with concrete in-fill supplied by the installing contractor on site and shall incorporate reinforcing bars, spaced 300 mm (12”) maximum on centers each way.
  - 6. Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections (if this information has been provided for configuration).
  - 7. Inertia bases for fans shall include motor slide rails as indicated on their Schedule.
  - 8. Inertia bases shall be a minimum of 150 mm (6”) thick.



## D. Isolator Types

1. Type 1 Isolator - Rubber Pads and Glass Fiber Pads:
  - a. Isolation pads shall be single ribbed or crossed, double ribbed elastomer-in-shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All pads shall be true elastomer-in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI (176 kg/cm<sup>2</sup>) tensile strength, oil resistant compounds with no color additives. Pads shall be 45 to 65 durometer and designed to permit 60 or 120 PSI (4.2 or 8.4 kg/cm<sup>2</sup>) loading at maximum rated deflections. When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project bid documents, not exceeding published load capabilities.
  - b. Fiberglass continuous support material shall be high-density matrix of compressed molded fiberglass; individually coated with a flexible, moisture-impervious elastomeric membrane, designed to allow controlled air movement in the fiber media. It shall be manufactured in such a way that the pumping action of air between fibers provides viscous damping, reducing motion caused by transient shock and vibration. The material shall be non-corrosive, non-combustible, non-absorbent, and resists rust, ozone, mildew and fungus, vermin proof and it shall not shrink, swell, or decompose. Isolation characteristics of the media shall be constant over a temperature range of -40°F to 250°F (40°C to 121°C).
2. Type 2 Isolators - Rubber Mounts and Hangers:
  - a. Vibration isolators shall be neoprene, molded from oil-resistant compounds, with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capabilities.
  - b. Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding .40" shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit.

3. Type 3 Isolators - Spring Isolators and Hangers:
  - a. Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock nut and washer for attachment to the supported equipment. The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.
  - b. Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding .4", shall be hangers consisting of a free-standing, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. The spring element shall meet all the specified characteristics described in above. The stamped or welded hanger bracket shall meet all the specified characteristics described above. Shall also be fitted with a self-centering load cap for the hanger rod.

E. Flexible Piping Connectors:

1. Domestic Water Systems:
  - a. Minimum ratings shall be 200 psi at 220 deg F.
  - b. Size 1-1/4" and smaller: Single sphere connector of neoprene and Kevlar tire cord fabric. Bead wires to prevent pull out. Basis of design: Mason Industries Type SFU.
  - c. Size 1-1/2" and larger: Twin sphere connector constructed of neoprene and Kevlar tire cord reinforcement. The raised rubber flanges must encase solid steel rings to prevent pull out. Flexible cable is not acceptable. Basis of design: Mason Industries Type SFDEJ.
2. Connectors shall be lead free for domestic water systems.
3. Flexible pipe connectors not required at in-line pump installations.

**PART 3 - EXECUTION**

**3.1 PERFORMANCE OF ISOLATORS**

- A. General: Comply with minimum static deflections recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, including definitions of critical and noncritical locations, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

**3.2 APPLICATIONS**

- A. General: Apply types of vibration isolation materials and units indicated at locations shown or scheduled. Selection is Installer's option where more than one type is indicated.

### **3.3 INSTALLATION**

- A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.
- B. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
- D. Locate isolation hangers as near overhead support structure as possible.
- E. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

### **3.4 EXAMINATION OF RELATED WORK**

- A. Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish written report to Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:
  - 1. Equipment installations (performed as work of other sections) on vibration isolators.
  - 2. Piping connections including flexible connections.
- B. Do not start up equipment until inadequacies have been corrected in manner acceptable to vibration isolation Installer.

**END OF SECTION 22 05 48**

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## SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of plumbing identification work required by this section is indicated on drawings and/or specified in other Division 22 sections.
- B. Type of identification devices specified in this section include the following:
  - 1. Painted identification materials
  - 2. Plastic pipe markers
  - 3. Plastic tape
  - 4. Valve tags
- C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division 22 sections.

#### 1.3 QUALITY ASSURANCE

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

#### 1.4 SUBMITTALS

- A. Schedules: Submit valve schedule for each piping system, formatted in an Excel spreadsheet with a digital copy provided to the Owner along with a printed copy on 8 1/2" x 11" paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut off and similar special uses, by special "flags", in margin of schedule. In addition, furnish extra copies for Maintenance Manuals.
- B. Labeling Nomenclature: Submit list indicating system types with appropriate nomenclature to be provided on the pipe labels. Where possible, match to system labels on drawings.

### PART 2 - PRODUCTS

#### 2.1 IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.

B. Painted Identification Materials:

1. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4" high letters for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
3. Identification Paint: Standard identification enamel of colors indicated, or, if not otherwise indicated for piping systems, comply with color chart below for colors.

C. Plastic Pipe Markers:

1. General: Provide manufacturer's standard pre-printed flexible or semi rigid, permanent, color coded, plastic sheet pipe markers.
2. Color: Color of pipe markers shall comply with ANSI A13.1.
3. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
  - a. Snap on application of pre tensioned semi rigid plastic pipe marker.
  - b. Adhesive lap joint in pipe marker overlap.
  - c. Laminated or bonded application of pipe marker to pipe (or insulation).
  - d. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1 1/2".
4. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full band or narrow strip type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
  - a. Laminated or bonded application of pipe marker to pipe (or insulation).
  - b. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
  - c. Strapped to pipe (or insulation) application of semi rigid type, with manufacturer's standard stainless-steel bands.
5. Lettering: Manufacturer's standard preprinted nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.
6. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

D. Plastic Tape:

1. General: Manufacturer's standard color-coded pressure sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
  - a. Width: Provide 1 1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes.
  - b. Color: Comply with color selection indicated for Plastic Pipe Markers.

- E. Valve Tags:
1. Brass Valve Tags: Provide polished brass valve tags with stamp engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
    - a. Provide 2" diameter tags, except as otherwise indicated.
    - b. Fill tag engraving with black enamel.
  2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.
  3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S hooks or heat sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- F. Name Plates:
1. General: Provide manufacturer's standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
  2. Lettering:
    - a. Large Equipment: 1 1/2" lettering as appropriate.
    - b. Small Equipment: 3/4" lettering as appropriate.
  3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

## 2.2 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.
1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

## PART 3 - EXECUTION

### 3.1 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.
- B. Piping System Identification:
1. General: Install pipe markers of one of the following types on each piping system, and include arrows to show normal direction of flow:
    - a. Stenciled markers, including color coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.

- b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
  - c. Stenciled markers, black or white for best contrast, wherever continuous color coded painting of piping is provided.
2. Locate pipe markers and color bands as follows wherever piping is exposed to view in unoccupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non concealed locations. Install all markers such that lettering is visible from the floor.
- a. Near each valve and control device.
  - b. Near each branch, excluding short take offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
  - c. Near locations where pipes pass through walls or floors/ceilings, or enter non accessible enclosures.
  - d. At access doors, manholes and similar access points which permit view of concealed piping.
  - e. Near major equipment items and other points of origination and termination.
  - f. Spaced intermediately at maximum spacing of 20' along each piping run with a minimum of one marker in each room.
  - g. On piping above removable acoustical ceilings.
- C. Valve Identification:
- 1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, plumbing fixture faucets, convenience and lawn watering hose bibs, and shut off valves at plumbing fixtures and similar rough in connections of end use fixtures and units. List each tagged valve in valve schedule for each piping system.
- D. Equipment Identification:
- 1. General: Provide equipment identification for all equipment including water heaters, heat exchangers, water softeners, and pumps.
  - 2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.
  - 3. Provide identification by means of nameplates or stenciled painting as appropriate.
    - a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.
    - b. Field insulated items, such as heat exchangers may be identified by plastic pipe markers or stenciled lettering.

**END OF SECTION 22 05 53**



## SECTION 22 07 00 - PLUMBING INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install insulation to all hot and cold surfaces of piping, tanks, fittings and other surfaces as required by the drawings and this section.
- B. Insulation shall include insulating materials, jackets, adhesive, mastic coatings, tie wire and other materials as required to complete the insulating work.

#### 1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Insulating materials, jackets, mastics, etc., shall meet flame spread and smoke developed ratings in accordance with NFPA-90A. Flame spread rating of not more than 25, smoke developed rating of not more than 50 as tested by ANSI/ASTM E84 (UL 723) (NFPA 255) method. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement tape and cloth shall have the same component ratings as specified above.
- B. Installation of insulation materials shall be in accordance with the latest edition of MICA/NIAC National Commercial & Industrial Standards for the appropriate material application.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type of plumbing insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each plumbing system requiring insulation.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- B. Protect insulation against dirt, water, and chemical and plumbing damage. Do not install damaged insulation; remove from project site.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Insulating Materials
  - 1. Owens/Corning Fiberglass Corp.
  - 2. Armacell
  - 3. Pittsburgh Corning Corp.

4. CertainTeed Corp.
5. Knauf Fiber Glass
6. John's-Manville Corp.
7. Aeroflex

B. Mastics and adhesives as recommended by insulation manufacturer.

## **2.2 PIPE INSULATION**

A. Type 'A': Preformed sectional heavy density fiberglass insulation and factory applied vapor barrier, all service jacket with pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 0 to +850 deg. F. Thermal conductivity shall be no more than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Owens Corning 25 ASJ/SSL.

1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.

B. Type 'B': Flexible elastomeric extruded pipe covering, 6 pound density, 0.27 K factor, water vapor permeance of 0.20 perms. Suitable for temperature from -40 deg. F to +220 deg. F. Equal to Armacell, AP Armaflex, joints sealed with adhesive as recommended by insulation manufacturer.

1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.

## **2.3 FITTING INSULATION**

A. Type 'A1': Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered with all-service jacket or low smoke PVC fitting covers. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket.

B. Type 'B1': Fittings: Insulate fittings, valve bodies, strainer bodies, etc., with mitercut pipe insulation or sheet insulation of same material as pipe covering.

## **2.4 EQUIPMENT INSULATION**

A. Type 'G':

1. Rigid fiberglass insulation board with factory applied all service jacket. Suitable for operating temperatures of 0 to +850 deg. F. Water vapor permeance of .02 perms. Equal to Owens Corning Series 700 with 25 ASJ facing.
2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. On round surfaces band insulation in place with 3/4" x 0.015" thick galvanized steel bands 18" on center. On flat or irregular surfaces impale insulation over welded pins on 12" centers and secure with speed washers.
3. Apply vapor seal ASJ pressure-sensitive patches at damaged areas. All insulation edges and butt joints are to be sealed with pressure-sensitive joint sealing tape to match the jacket. Apply in accordance with manufacturers recommendations.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Use only experienced applicators regularly engaged in the trade. Rough work will be rejected. Application details shall be in accordance with the insulating materials supplier's recommendations except where a higher standard is specified. All surface finishes shall be extended in such a manner as to protect all raw edges, cuts and surfaces of insulation.
- B. Do not insulate the following:
  - 1. Valve bonnets
  - 2. Unions in hot piping
  - 3. Preinsulated expansion joints
- C. Inspect all piping and equipment before applying insulation to ensure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
- D. Covering for "cold" pipes shall pass unbroken through hanger clevises, sleeves, etc. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided as required to prevent condensation. The same covering and hanging detail shall be used for pipes connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between pipes and hangers.
- E. Insulation at removable heads, strainer plugs, and other access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.

**\*\*\*\*\*NOTE: Not all services may apply – refer to plans for scope of services. \*\*\*\*\***

**3.2 INSULATION SCHEDULE**

Service	Type Insulation and Thickness*
<u>Above Ground Piping</u>	
Domestic cold water lines (including all pipe material types)	Type A and A1: All pipe sizes – 1" thick  Type B and B1: 1-1/4" and smaller – 1/2" thick 1-1/2" and larger – 1" thick
Domestic hot water, tempered water, and recirculating lines (including all pipe material types)	Type A and A1: 1 1/4" and smaller – 1" thick 1-1/2" and larger – 1-1/2" thick  Type B and B1: 1 1/4" and smaller – 1" thick 1-1/2" and larger – 1-1/2" thick
Storm piping, sump pump discharge lines. Sanitary vent piping within ten feet of roof penetration	Type A and A1: 1" thick for all pipe sizes

Service	Type Insulation and Thickness*
Underside of roof drain bodies	Type G: 1" thick
<p style="text-align: center;"><u>Underground Piping</u></p> <p>Domestic hot water lines and recirculation lines (including all pipe material types)</p>	<p>Type B and B1:  1 1/4" and smaller – 1" thick  1-1/2" and larger – 1-1/2" thick</p>
<p>* Insulation type and thickness indicated in table apply for all pipe materials.  **For piping exposed to outdoor ambient temperatures, including but not limited to piping routed in the LEC roof chase, increase thickness by 1/2"</p>	

**END OF SECTION 22 07 00**

## SECTION 22 11 16 - DOMESTIC WATER PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
  - 1. Extent of domestic water piping work is indicated on drawings and schedules, and by requirements of this section.
  - 2. Insulation of domestic water piping is specified in other Division 22 sections and is included as work of this section.
  - 3. Installation of valves for domestic water piping system is specified in other Division-22 sections and is included as work of this section.

#### 1.3 QUALITY ASSURANCE

- A. ASME Compliance: Fabricate and install domestic water piping in accordance with ASME B31.9 "Building Services Piping".
- B. UPC Compliance: Fabricate and install domestic water piping in accordance with IAMPO "Uniform Plumbing Code".
- C. IPC Compliance: Fabricate and install domestic water piping in accordance with the "International Plumbing Code".
- D. Plumbing and Drainage Institute: Fabricate and install domestic water piping with Standard PDI-WH201.
- E. ANSI/NSF 372 Certification: All potable water supply piping, valves, fittings, and fixtures (excluding toilets, urinals, fill valves, flush valves, shower valves, and main gate valves greater than 2") shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

#### 1.4 SUBMITTALS

- A. Submit manufacturer's material data and installation methods for each type of system to be provided.
- B. Submit manufacturer's catalog cuts for each type of device to be used.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Backflow Preventers
  - 1. Watts
  - 2. Apollo Valves
  - 3. Febco
  
- B. Water Hammer Arrestors
  - 1. Ancon
  - 2. Sioux Chief
  - 3. Wade
  - 4. Watts
  - 5. Zurn
  
- C. Copper Pressure Seal Fittings
  - 1. Viega Pro Press
  - 2. NIBCO Press System
  
- D. Commercial Expansion Tanks
  - 1. Bell & Gossett
  - 2. Amtrol
  - 3. Spiro Therm
  - 4. Wessels

### **2.2 BASIC MATERIALS AND PRODUCTS**

- A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with Uniform Plumbing Code and International Plumbing Code where applicable, base pressure rating on domestic water piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in domestic water piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
  
- B. Valves: Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.
  
- C. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
  
- D. Expansion Compensation: Refer to Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.
  
- E. Meters and Gauges: Refer to Section 22 05 19 - Meters and Gages for Plumbing Piping.
  
- F. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

**2.3 PIPE:**

- A. Provide pipe materials meeting the following criteria and referenced standards:
1. Ductile Iron Pipe (D-Iron): Cement lined ductile iron, ANSI/AWWA C104/A21.4.
  2. Polyvinyl Chloride (PVC): DR18 ANSI/AWWA C900 or C905 with tracer wire.
  3. Type K Copper (K Cu): Type K copper water tube, hard temper, ASTM B88.
  4. Type L Copper (L Cu): Type L copper water tube, hard temper, ASTM B88.
  5. Brass (Brass): Schedule 40 Chromium plated, ASTM B43.
  6. Cross Linked Polyethylene (PEX): Cross-linked polyethylene PEXa (DIN 4726) , ASTM F876, ASTM F877, ASTM F1960.
- B. Unless specifically prohibited by local codes, provide piping materials for systems indicated according to the following table:

Service	Material						
	D-Iron	PVC	K Cu	L Cu	Brass	PEX	St St
Underground water service main for domestic water, smaller than 2"			X				
Underground water service main for domestic water, 2" and larger	X	X					
Underground water service main for Fire Suppression (FX)	X	X					
Above ground water service main (combined domestic/FX service)	X						
Domestic water below slab			X				
Water service pipes 2" and smaller		X	X				
Above ground domestic water				X		X	X
Exposed fixture connections					X		

**2.4 FITTINGS:**

- A. Cast iron water pipe: Class 250 ANSI A21.20, AWWA C110-71, standard mechanical joint fittings.
- B. Copper water tube cast bronze or wrought copper:
1. Solder joint type. ANSI B16.18 and B16.22-63. Where copper piping is used for combined water/fire protection water service, joints upstream of fire protection backflow preventer shall be brazed.
  2. Pressure Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM. Installation per manufacturer's recommendations.
- C. Brass pipe: Cast bronze screwed, 125-pound, flat band water pattern, chromium plated, for chromium plated pipe.
- D. Cross-Linked Polyethylene (PEX) (domestic water): ASTM F1960 utilizing expander fittings. ASTM F1960 brass fittings ANSI/NSF 14 and 61 certified.

## **2.5 JOINTS**

- A. Copper water tube:
  - 1. Use non-corrosive 95-5 tin-antimony solder, cut pipe square, clean, ream and polish tube ends and inner surfaces of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings. Where copper piping is used for combined water/fire protection water service, joints upstream of fire protection backflow preventer shall be brazed.
  - 2. Pressure Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM.
- B. Cross-Linked Polyethylene (PEX) (domestic water): ASTM F1960 utilizing expander fittings. ASTM F1960 brass fittings ANSI/NSF 14 and 61 certified.

## **2.6 NIPPLES AND UNIONS**

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions.
- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
  - 1. Long runs, at intervals of 80 feet.
  - 2. In by-pass around equipment, valves, and controls.
  - 3. In connections to equipment.
  - 4. Where indicated on drawings.
- D. Dielectric unions shall be installed between any connection of copper pipe and ferrous piping or equipment. In grooved piping systems, provide Clearflo by Victaulic.

## **2.7 AIR VENTS**

- A. Manual Air Vents: Bell & Gossett Model No. 17SR.
- B. Automatic Air Vents: Bell & Gossett Model No. 7

## **2.8 BACKFLOW PREVENTERS**

- A. Reduced Pressure Zone Backflow Preventer:
  - 1. General: A reduced pressure zone backflow preventer shall be installed at each cross connection or at the water meter to prevent back-siphonage and backpressure backflow of hazardous materials into the potable water supply.
  - 2. The device shall consist of a pressure differential relief valve located in a zone between two positive seating check valves. The assembly shall include two tightly closing shut-off valves before and after the device, test cocks and a protective strainer upstream of the No. 1 shut-off valve. The reduced pressure zone backflow preventer shall have all access port covers secured with stainless steel screws which are bolted to valve body. Vent outlet to have suitable connections for an air gap. All components of the backflow preventer assembly shall meet the requirements for ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.



3. The device shall meet the requirements of ANSI/ASSE Standard 1013 and AWWA Standard C506, be listed by IAPMO (UPC) and be approved by FCCCHR at USC. Provide with air gap fitting for discharge. Basis of design to be:
  - a. Watts Regulator Co. Series LF009QT-S – size 3/4" thru 2".
  - b. Watts Regulator Co. Series LF909QT-S – size 3/4" thru 2", Series LF909-OSY-S-FDA - size 2-1/2" thru 10".
  - c. Watts Regulator Co. Series LF957 – size 2-1/2" thru 10".
  - d. Zurn Wilkins 375 – size 2 1/2" thru 10".
  
- B. Reduced Pressure Zone Backflow Preventer: Pressure Vacuum Breakers: A pressure anti-siphon vacuum breaker shall be installed at all threaded hose connections and where indicated on the plans to prevent the back-siphonage of contaminated water. This assembly is not to be used where there is a possibility that a back-pressure condition may develop. The assembly will incorporate an acetyl bonnet with silicone rubber o-ring seal and silicone rubber seat disc. The valve shall have replaceable seats. Check assembly shall be guided over its full stroke by V notched guides. The assembly shall meet the requirements of ANSI/ASSE Standard 1020. Where vacuum breaker is not integral to trim, unit shall be equal to Watts Regulator Company Series 800M4QT.

## **2.9 WATER HAMMER ARRESTORS**

- A. Water hammer arrestors shall be piston type with seamless copper chamber, two O-ring piston and a 60 psi charge. Water hammer arrestors shall be sized, tested and certified in accordance with the Plumbing and Drainage Institute Standard PDI-WH201 and American Society of Sanitary Engineering Standard ASSE-1010.

## **2.10 EXPANSION TANKS**

- A. Furnish and install pre-charged steel expansion tanks as indicated on plans. Tanks shall have integral heavy-duty Butyl rubber diaphragm, NPT system connection(s), and a .302" - 32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank shall be suitable for potable water and be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125 PSI working pressure.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. General: Examine areas and conditions under which domestic water piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

### **3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS**

- A. General: Install basic materials and products as per manufacturers' recommendations, Uniform and International Plumbing Codes, local code requirements and as required to meet system pressure and performance requirements.
  
- B. Piping Protection: Protect piping from damage during construction, including, but not limited to covering pipes during application of spray on fire-proofing to prevent fire proofing material from coming in contact with the pipes.

- C. Valves
  - 1. Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.
  - 2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.
  - 3. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures and elsewhere as indicated.
  - 4. Shutoff Valves: Install on inlet and outlet of each domestic water equipment item and elsewhere as indicated.
  - 5. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
- D. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
- E. Expansion Compensation Products: Refer to Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.
- F. Meters and Gauges: Refer to Section 22 05 19 - Meters and Gages for Plumbing Piping.
- G. Supports and Anchors: Refer to Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

### **3.3 DOMESTIC WATER PIPING**

- A. Install pipe for all domestic water and domestic water systems as indicated on drawings, as called for in other sections, and as specified herein.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
- D. Check all piping for interference with other trades; avoid placing water pipes over electrical equipment.
- E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
- F. Extend cold water and hot water piping to each fixture and other equipment requiring water supplies.
- G. Pitch pipes to accessible drainage point where unions, plugged tees or drainage valves shall be provided.
- H. Branch take off pipe connections shall come off the top of mains.
- I. Pipes built into masonry or concrete construction shall be wrapped with tar paper or burlap to prevent bonding to the concrete.
- J. No pipe shall be located in an outside wall or other location where freezing is likely to occur.

- K. No pipe shall be in contact with, or attached to, a structural member in a manner that causes the transmission of noise to the structure. Block ends of runs to prevent movement due to water hammer.

### **3.4 EQUIPMENT CONNECTIONS**

- A. Refer to Section 22 11 23 - Domestic Water Pumps, 22 33 00 - Electric Domestic Water Heaters, 22 34 00 - Fuel Fired Domestic Water Heaters, and 22 35 00 - Domestic Water Heat Exchangers.
- B. General: Connect domestic water piping system to plumbing equipment as indicated and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.

### **3.5 INSTALLATION OF FIXTURES**

- A. Refer to Section 22 40 00 - Plumbing Fixtures, and 22 47 00 - Drinking Fountains and Water Coolers.
- B. General: Connect water piping system to plumbing fixtures as indicated and comply with manufacturer's instructions where not otherwise indicated.
- C. Refer Water supply to all fixtures and containers shall be so installed as to prevent back siphonage of polluted water into the water supply. All supplies shall be either above the flood rim of the fixture or separated from the drainage end by means of approved vacuum breakers

### **3.6 INSTALLATION OF BACKFLOW PREVENTERS**

- A. Install backflow preventers where required per local code and in accordance with manufacturer's recommendations. Backflow preventers to be installed accessible for testing, installing contractor shall provide testing by a certified backflow assembly tester at time of installation as required by the International Plumbing Code. Install air gap fitting and pipe to nearest floor drain.

### **3.7 INSTALLATION OF WATER HAMMER ARRESTORS**

- A. Install water hammer arrestors as indicated on the drawings and as required per Plumbing and Drainage Institute Standard PDI-WH201. Water hammer arrestors to be installed in accessible locations where possible.

### **3.8 INSTALLATION OF PLUMBING SPECIALTIES**

- A. General: Install plumbing specialties and valves as per manufacturer's installation instructions.
- B. Provide unions, valves to units at each connection as required by inspection.

### **3.9 HYDROSTATIC TESTING**

- A. General: New water mains shall be subject to hydrostatic testing in accordance with AWWA C600 and other applicable AWWA Standards of latest revision and the following supplemental instructions.
- B. Supplemental Instructions:
  - 1. All newly laid pipe or any valved section thereof shall be subject to a hydrostatic pressure of 1.5 X the working pressure at the point of testing or 100 psig, whichever is greater.

2. The test procedures shall:
  - a. Not exceed pipe or thrust restraint design pressures.
  - b. Be of at least 4-hour duration.
  - c. Not exceed the rated pressure of the valves or hydrants.
3. Each valved section of pipe shall be filled with water slowly and the specified test pressure shall be applied by means of a pump connected to the pipe.
4. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves and hydrants.
5. Any damaged or defective pipe, fittings, valves or hydrants that are discovered following the pressure test shall be repaired or replaced with sound material and the test shall be repeated.
6. A leakage test shall be conducted concurrently with the pressure test. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain test pressure.
7. No pipe installation will be accepted where leakage is observed.

### **3.10 DISINFECTION**

- A. General: Upon completion of a newly installed piping or when repairs to an existing pipe are made, the piping shall be disinfected according to instructions listed in AWWA C651, local codes, and local utility requirements.
- B. Repairs: Repairs to mains and plumbing shall be disinfected by swabbing with hypochlorite and flushing in accordance with AWWA C651.

**END OF SECTION 22 11 16**

## SECTION 22 11 23 - DOMESTIC WATER PUMPS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of plumbing pumps work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of pumps specified in this section include the following:
  - 1. In-line Circulators
  - 2. In-line Pumps
- C. Refer to Division-26 sections for the following work; not work of this section:
  - 1. Power supply wiring from power source to power connection on pumps. Include starters, disconnects and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.

#### 1.3 QUALITY ASSURANCE

- A. UL Compliance: Design, manufacturer and install pumps in accordance with UL 778 "Motor Operated Water Pumps".
- B. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- C. ANSI/NSF 372 Certification: Domestic Water Pumps shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

## **1.5 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Handle pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged pumps or components; replace with new.
- B. Store pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. In-Line Circulators and Pumps
  - 1. Armstrong Pumps, Inc.
  - 2. Aurora
  - 3. Bell & Gossett ITT; Fluid Handling Div.
  - 4. Grundfos
  - 5. Taco, Inc.
- B. General: Provide factory tested pumps, thoroughly cleaned and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

### **2.2 IN-LINE CIRCULATORS**

- A. General: Provide in-line circulator pumps where indicated, and of capacities as scheduled. In-line circulators shall be of either all bronze or stainless-steel construction.
- B. Type: Horizontal mount, permanently lubricated, designed for 150 psi working pressure and 225 deg. F continuous water temperature.
- C. Construction: Cast bronze or stainless-steel body with suction and discharge flanges. Steel shaft mounted on permanently lubricated, sealed ball-bearings. Water-tight seal fill mechanical carbon on silicon carbide face seals.
- D. Impeller: Composite construction, enclosed type, hydraulically and dynamically balanced, and keyed to shaft.
- E. Motor: Non-overloading at any point on pump curve, drip-proof, permanently sealed ball bearings, resilient mounted construction, permanent split capacitor with thermal overload protection, single phase motors.
- F. Controls: Provide circulator with integral time clock.

### **2.3 IN-LINE PUMPS**

- A. General: Provide in-line centrifugal pumps where indicated, and of capacities as scheduled. In-line pumps shall be of all bronze construction.
- B. Type: Single-stage, close-coupled, vertical split case design, horizontal mount, permanently lubricated type, designed for 175 psi working pressure, and 225 deg. F continuous water temperature.

- C. Construction: Cast bronze body with suction and discharge flanges, gauge (suction and discharge), vent and drain ports. Solid steel shaft with bronze shaft-sleeve, mounted on permanently lubricated, sealed ball-bearings. Internally flushed, carbon, mechanical seals. The pump internals shall be capable of being serviced without disturbing piping connections.
- D. Impeller: Cast bronze, hydraulically and dynamically balanced, keyed to the shaft and secured by a locking brass cap screw or nut.
- E. Coupling: A flexible type coupling shall be employed between the pump and motor.
- F. Motor: Motors through 1 HP shall be resilient mounted, motors over 1.5 HP shall be rigid mounted. Motors shall have permanently lubricated ball bearings and maintenance free. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
- G. Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine areas and conditions under which pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable with Installer.

#### **3.2 INSTALLATION OF PUMPS**

- A. General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Support: Install in-line pumps, supported from piping system. See Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment for vibration isolation of piping system.
- D. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer for power wiring.
  - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- E. Piping Connections: Refer to Division-22 Plumbing piping sections. Provide piping, valves, accessories, gauges and supports as indicated, including the following:
  - 1. Strainer and shut-off valve in suction line.
  - 2. Check valve, balancing/shut-off valve in discharge line. At contractor's option, an indicating type butterfly valve may be used in lieu of balancing cock and shut-off valve.
  - 3. Compound gauge with turn cocks connected between pump suction and discharge.

### **3.3 ADJUSTING AND CLEANING**

- A. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- B. Start-up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

**END OF SECTION 22 11 23**



## SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
  - 1. Extent of sanitary waste and vent piping work is indicated on drawings and schedules, and by requirements of this section.

#### 1.3 QUALITY ASSURANCE

- A. UPC Compliance: Fabricate and install sanitary waste and vent piping in accordance with IAMPO "Uniform Plumbing Code".
- B. IPC Compliance: Fabricate and install sanitary waste and vent piping in accordance with the "International Plumbing Code".
- C. Plumbing and Drainage Institute: Fabricate and install domestic water piping with Standard PDI-WH201.

#### 1.4 SUBMITTALS

- A. Submit manufacturer's catalog cuts for each type of device to be used.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Floor Drains
  - 1. Jay R. Smith
  - 2. Jonespec
  - 3. Josam
  - 4. Wade
  - 5. Watts
  - 6. Zurn

## 2.2 BASIC MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with International and Uniform Plumbing Codes. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in sanitary waste and vent piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
- C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

## 2.3 PIPE:

- A. Provide pipe materials meeting the following criteria and referenced standards:
  1. Cast Iron Soil Pipe (C-Iron): Service class, bell and spigot, asphalt coated, ASTM A74.
  2. No-Hub Cast Iron Soil Pipe (C-Iron NH): Service class, no hub, asphalt coated, CISPI 301 or ASTM A-888.
  3. Polyvinyl Chloride (PVC): Schedule 40, DWV, ASTM D1785 and ASTM D2665.
  4. Type K Copper (K Cu): Type K copper water tube, hard temper, ASTM B88.
  5. Type M Copper (M Cu): Type M copper water tube, hard temper, ASTM B88.
  6. Brass (Brass): 17 gauge brass tube, chromium plated, ASTM B43.
  7. Acid Resistant Fire-Retardant Polypropylene (FR PP): Schedule 40 drainage pipe.
  8. Acid Resistant Polypropylene (PP): Schedule 40 drainage pipe.
  9. Chlorinated Polyvinyl Chloride (CPVC): Schedule 40, ASTM Cell Classification 23447, manufactured in accordance with ASTM F 2618.
- B. Unless specifically prohibited by local codes, provide piping materials for systems indicated according to the following table:

Service	Material								
	C-Iron	C-Iron NH	PVC	K Cu	M Cu	Brass	FR PP	PP	CPVC
Sanitary waste and vent below slab to 5' outside building perimeter	X	X	X						
Sanitary waste and vent above slab, up to and including 2-1/2"		X	X		X				
Sanitary waste and vent above slab, 3" and larger	X	X	X		X				
Exposed fixture connections						X			
Urinal Branch Waste Pipes			X						

**2.4 FITTINGS:**

- A. Material and strength of fittings for sewer pipe, conform to pipe as per ASTM Standards.
- B. PVC pipe fittings (below grade sanitary sewer): Provide fittings produced and recommended for the service indicated by manufacturer of piping.
- C. PVC DWV pipe fittings: ASTM D2665 DWV Schedule 40 socket type. Provide fittings produced and recommended for the service indicated by manufacturer of tubing. Solvent cements as per ASTM 2564.
- D. Copper drainage tube: Cast bronze fittings, solder joint fittings. ANSI B16.23.
- E. Brass pipe: Cast bronze screwed, 125 pound, flat band water pattern, chromium plated, for chromium plated pipe.

**2.5 JOINTS**

- A. Cast iron bell and spigot soil pipe: Pack joints with oakum, fill with molten lead at one pouring, caulk solid flush with hub rim. If approved by Code, pre-set plastic or neoprene joint may be used, ASTM C 564.
- B. Cast iron no-hub pipe: Coupling assembly tightened by torque wrench, CISPI 310, ASTM C 564.
- C. PVC pipe fittings (below grade sanitary sewer): Listed compression type joints.
- D. PVC DWV pipe: Solvent cement in accordance with ASTM D2564.
- E. Copper drainage tube: Use non-corrosive 50-50 solder, cut pipe square, clean, ream and polish tube ends and inner surface of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings. Use same method for copper refrigerant pipe, except use silver solder with 5% silver content, or equal strength brazing alloy.

**2.6 VENTS**

- A. Vents through the roof shall be cast iron long increasers beginning at 12" under the roof and extending at least above the highest possible water level on the roof but in no case less than 8". Size increases as follows:

<u>Vent Size</u>	<u>Increase To</u>
1-1/4" and 1-1/2"	3" minimum
2" and 2-1/2"	4" minimum
3"	4"
4"	6"

- B. Provide and install flashing for each vent through the roof. The flashing shall extend up around the pipe and be sealed to the pipe and shall extend over the roof deck at least one foot in each direction from the base.

**2.7 FLOOR DRAINS**

- A. Shall be of the style as called for in fixture schedule.

- B. Drains without integral traps shall have service class p-traps.

## **2.8 CLEANOUTS**

- A. In floors of finished areas: cast iron caulking ferrule for soil pipe hub with brass countersunk plug and cast brass round flush access cover with polished top.
- B. In floors of unfinished areas: cast iron with tapered body for caulking into soil pipe hub, with brass countersunk plug.
- C. In walls of finished areas: cast brass raised head plug and round stainless steel cover plate with polished top and countersunk cover screw. Provide with caulking ferrule where installed in cast iron soil pipe.
- D. In walls of unfinished areas: cast brass raised head, iron pipe size male threads. Provide with caulking ferrule where installed in iron soil pipe.
- E. In floors of areas subject to vehicular travel: cast iron with tapered body for caulking into soil pipe hub, with brass countersunk plug. Weight rated for fork truck and heavy traffic duty.

## **2.9 INSPECTION**

- A. General: Examine areas and conditions under which sanitary waste and vent piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

## **2.10 INSTALLATION OF BASIC MATERIALS AND PRODUCTS**

- A. General: Install basic materials and products as required per manufacturer=s recommendations, International and Uniform Plumbing Codes, local code requirements and as required to meet the intent of the documents.
- B. No soil or waste pipe shall be covered by earth or construction without first being proved free of leaks by a hydrostatic test of at least 10 feet head.
- C. Install vents in practical alignment and supported with constant pitch back to the drainage system, concealed from finished spaces, unless shown or directed otherwise.
- D. Soil, waste and vent connections to fixtures shall be accurately located and concealed from finished spaces, unless indicated otherwise.
- E. Connections to horizontal branches shall be at 45 deg. angle using Wye or Tee-Wye. Connection to vertical stacks shall be with Sanitary Tee or Tee-Wye at 45 deg.

## **2.11 SANITARY WASTE AND VENT PIPING**

- A. Install pipe for all sanitary waste and vent systems as indicated on drawings, as called for in other sections, and as specified herein.

- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Provide proper support to maintain uniform fall of 1/4" per foot for lines 3" and smaller and 1/8" per foot for lines 4" and larger. Protect all openings against the entrance of dirt. Where piping must cross footings, the piping shall cross under footings unless noted otherwise on the drawings.
- D. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.
- E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
- F. Piping Specialties: Refer to Section 22 0500 - Common Work Results for Plumbing.
- G. Supports, Anchors and Seals: Refer to Section 22 0529 - Hangers and Supports for Plumbing Piping.
- H. Equipment Connections
  - 1. General: Connect sanitary waste and vent piping system to plumbing equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.
- I. Field Quality Control
  - 1. Piping Tests: Test sanitary waste and vent piping in accordance with testing requirements of Division 22 Basic Materials and Methods, Section 22 0010 - Plumbing General Provisions.
- J. Underground installation of thermoplastic pipe shall be done in accordance with ASTM D 2321.

## **2.12 INSTALLATION OF CLEANOUTS**

- A. Provide a cleanout at the base of each stack where the sewer leaves the building and at other points where required by code and good practice. Cleanout spacing shall not exceed 50'-0" on long runs. Cleanouts shall be the same size as pipe up to and including 6" for 6" or larger pipes. Cleanouts for concealed pipes shall be set flush with floor and wall surfaces.

## **2.13 INSTALLATION OF FLOOR DRAINS**

- A. Obtain exact finished floor levels from the General Contractor and set floor drain top rims accurately to proper level below finished floor to allow for proper slope towards drains.

## **2.14 INSTALLATION OF FIXTURES**

- A. Refer to Section 22 4000 - Plumbing Fixtures, 22 46 00 - Security Plumbing Fixtures, and 22 47 00 - Drinking Fountains and Water Coolers.

**END OF SECTION 22 13 16**

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## SECTION 22 13 29 - SANITARY SEWERAGE PUMPS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of plumbing equipment work is indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.
- B. Types of plumbing equipment required for project include the following:
  - 1. Sewage Ejectors

#### 1.3 QUALITY ASSURANCE

- A. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- B. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start up instructions, and capacity and ratings, with selection points clearly marked.
- B. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Sewage Ejector
  - 1. Weil Pump Co.
  - 2. Federal Pump Corp

#### 2.2 SEWAGE EJECTORS

- A. Vertical Shaft Sewage Ejectors
  - 1. General: Provide sewage ejectors as indicated, of size and capacity as scheduled.
  - 2. Pump: Duplex vertical shaft suspended wet-pit type sewage ejector with cast iron casing.
  - 3. Shaft: Stainless steel.
  - 4. Motor: Open, drip-proof ball bearing type, electrical characteristics as scheduled.

5. Basin: Fiberglass construction of indicated dimensions, with inlet connections of size and location as indicated. Maintain minimum of 3' depth below lowest inlet invert.
6. Cover: Basin shall have steel cover with required openings for pumps, controls, manhole, and vent connection. Cover shall be treated with a corrosion-resistant coating.
7. Controls: Provide mechanical float switches and control panel including alternator, high water alarm, contacts for remote alarm, and integral disconnect.

### 2.3 PIPE:

	<u>Material</u>	<u>Service</u>
A.	Copper water tube, hard temper ASTM B88  Type L or Type M	Pump discharge lines.
B.	Polyvinyl Chloride Pipe (PVC) Schedule 40 DWV, ASTM D1785 and ASTM D2665.	Pump discharge lines.

### 2.4 FITTINGS:

- A. PVC DWV pipe fittings: ASTM D2665 DWV Schedule 40 socket type. Provide fittings produced and recommended for the service indicated by manufacturer of piping.
- B. Copper drainage tube: Cast bronze fittings, solder joint fittings, ANSI B16.23

### 2.5 JOINTS

- A. PVC DWV pipe: Solvent cement in accordance with ASTM D2564.
- B. Copper drainage tube: Use non-corrosive 50-50 solder, cut pipe square, clean, ream and polish tube ends and inner surface of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF SEWAGE EJECTORS

- A. General: Install sewage ejectors as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.
  1. Basin: Set basin in indicated location, connect to sewer inlet. Brace interior of basin in accordance with manufacturer's instructions, to prevent distortion or collapse during concrete placement. Refer to Division 3 for concrete work; not work of this section.
  2. Cover: Set cover over basin; fasten to top flange of basin. Install so cover is flush with finished floor.
  3. Pump: Set pumps and assemble float control system. Plumb pump assembly. Connect discharge piping with check valve and union or flanges. Maintain clear space above the pump greater than or equal to the basin depth to allow for removal of the vertical shaft pump.
  4. Electrical: Refer to Division 16 for power wiring; not work of this section.
  5. Start up: Start up, test, and adjust sewage ejector in accordance with manufacturer's start up instructions. Check and adjust float controls for proper operation.



### **3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS**

- A. General: Install basic materials and products as per manufacturers' recommendations, Uniform and International Plumbing Codes, local code requirements and as required to meet system pressure and performance requirements.
- B. Valves
  - 1. Refer to Section 22 05 23 - General Duty Valves for Plumbing Piping.
  - 2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.
  - 3. Shutoff Valves: Install where indicated.
  - 4. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
- C. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
- D. Supports, Anchors and Seals: Refer to Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

### **3.3 SEWAGE EJECTOR PUMP PIPING**

- A. Install pipe as indicated on drawings, as called for in other sections, and as specified herein.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
- D. Check all piping for interference with other trades; avoid placing water pipes over electrical equipment.
- E. Pipes built into masonry or concrete construction shall be wrapped with tar paper or burlap to prevent bonding to the concrete.
- F. No pipe shall be located in an outside wall or other location where freezing is likely to occur.
- G. No pipe shall be in contact with, or attached to, a structural member in a manner that causes the transmission of noise to the structure. Block ends of runs to prevent movement due to water hammer.

### **3.4 TESTING**

- A. General: New pump discharge piping shall be tested and proved tight under a static pressure of 1.5x pump discharge head. The pressure shall be maintained for (2) two / (4) four hours.

**END OF SECTION 22 13 29**

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## SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
  - 1. Extent of storm drainage piping work is indicated on drawings and schedules, and by requirements of this section.
  - 2. Insulation of storm drainage piping is specified in other Division 22 sections and is included as work of this section.

#### 1.3 SUBMITTALS

- A. Submit catalog cuts giving manufacturer's model numbers, rough in dimensions, and construction material for each type of site drain and roof drain.
- B. Submit material data and installation method for each piping service.

#### 1.4 QUALITY ASSURANCE

- A. UPC Compliance: Fabricate and install storm drainage piping in accordance with IAMPO "Uniform Plumbing Code".
- B. IPC Compliance: Fabricate and install storm drainage piping in accordance with the "International Plumbing Code".

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Site Drains and Roof Drains
  - 1. Jay R. Smith
  - 2. Josam
  - 3. Wade
  - 4. Zurn
  - 5. Watts

**2.2 BASIC MATERIALS AND PRODUCTS**

- A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with International and Uniform Plumbing Codes. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in storm drainage piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
- C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

**2.3 PIPE:**

- A. Provide pipe materials meeting the following criteria and referenced standards:
  1. Cast Iron Soil Pipe (C-Iron): Service class, bell and spigot, asphalt coated, ASTM A74.
  2. Cast Iron Soil Pipe (C-Iron NH): Service class, no hub, asphalt coated CISPI 301 or ASTM A-888.
  3. Concrete Sewer Pipe (Conc): Extra strength bell and spigot ASTM C14, Table II.
  4. Reinforced Concrete Sewer Pipe (R-Conc): Bell and spigot, ASTM C76.
  5. Polyvinyl Chloride Pipe (PVC): Schedule 40, DWV, ASTM D1785 and ASTM D2665.
  6. Polyvinyl Chloride Pipe (PVC-ext): PSM SDR-35 or PS-46. ASTM D3034 or ASTM F789.
- B. Unless specifically prohibited by local codes, provide piping materials for systems indicated according to the following table:

Service	Material			
	C-Iron	C-Iron NH	PVC	PVC-ext
Storm sewers more than 5' outside building perimeter, 4" in dia. and larger.				X
Below slab storm sewers inside the building and to 5' outside building perimeter	X	X	X	
Above slab storm sewers	X	X	X	

**2.4 FITTINGS:**

- A. Material and strength of fitting for sewer pipe shall conform to pipe as per ASTM Standards.
- B. PVC pipe fittings (below grade sanitary sewer): Provide fittings produced and recommended for the service indicated by manufacturer of piping.
- C. PVC DWV pipe fittings: ASTM D2665 DWV Schedule 40 socket type. Provide fittings produced and recommended for the service indicated by manufacturer of tubing. Solvent cements as per ASTM 2564.

## **2.5 JOINTS**

- A. Concrete pipe: Pipe manufacturer's standard preformed pre-set plastic or rubber joint, installed in accordance with manufacturer's instructions. Acceptable manufacturers: Amvit, Tylox or Kent.
- B. Cast iron bell and spigot soil pipe: Pack joints with oakum, fill with molten lead at one pouring, caulk solid flush with hub rim. If approved by Code, pre-set plastic or neoprene joint may be used, ASTM C 564.
- C. Cast iron no-hub pipe: Coupling assembly tightened by torque wrench, CISPI 310, ASTM C 564.
- D. PVC pipe fittings (below grade sanitary sewer): Listed compression type joints.
- E. PVC DWV pipe: Solvent cement in accordance with ASTM D2564.

## **2.6 DRAINAGE PIPING PRODUCTS**

- A. General: Provide factory fabricated drainage piping products of size and type indicated. Where not indicated, provide proper selection as determined by Installer to comply with the installation requirements and governing regulations.
- B. Cleanout Plugs: Cast bronze or brass, threads complying with ANSI B2.1, countersunk head.
  - 1. Nickel Bronze Top: Manufacturer's standard cast unit of pattern indicated:
    - a. Pattern: Exposed flush type, standard non slip scored or abrasive finish.
  - 2. Cast Iron Top: Manufacturer's standard cast unit of pattern indicated:
    - a. Pattern: Exposed flush type, standard non slip scored or abrasive finish.
- C. Wall Cleanouts: Cast iron body adaptable to pipe with cast bronze or brass cleanout plug; stainless steel cover including screws.
- D. Flashing Flanges: Cast iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.

## **2.7 ROOF DRAINS**

- A. General: Provide roof drains of size as indicated on drawings; and type, including features, as specified on the drawings.
- B. Roof drain castings shall contain four (4) equally spaced clamping ring bolts. Drains, clamping rings, extensions, and under deck clamps shall be painted cast iron.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. General: Examine areas and conditions under which storm drainage piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

### **3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS**

- A. General: Install basic materials and products as required per manufacturer=s recommendations, International and Uniform Plumbing Codes, and as required to meet the intent of the documents.
- B. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.
- C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.
- D. Lay building storm drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements and other special installation requirements. Clear interior of piping of dirt and other superfluous materials as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops. Where piping must cross footings, the piping shall cross under footings unless noted otherwise on the drawings.
- E. Install storm water piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 3" and smaller and 1/8" per foot (1%) for piping 4" and larger.

### **3.3 STORM DRAINAGE PIPING**

- A. Install pipe for all storm drainage systems as indicated on drawings, as called for in other sections, and as specified herein.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
- D. Check all piping for interference with other trades; avoid placing water pipes over electrical equipment.
- E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
- F. Underground installation of thermoplastic pipe shall be done in accordance with ASTM D 2321.

### **3.4 FIELD QUALITY CONTROL**

- A. Piping Tests: Test storm drainage piping in accordance with testing requirements of Division 22 Basic Materials and Methods, Section 22 00 10 - Plumbing General Provisions.

### **3.5 INSTALLATION OF DRAINAGE PIPING PRODUCTS**

- A. Cleanouts: Install in conductor piping and building storm drain piping as indicated, as required by Uniform Plumbing Code; at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping; at base of each conductor; and where the line leaves the building. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.
- B. Flashing Flanges: Install flashing flange and clamping device with each cleanout passing through waterproof membrane.

### **3.6 INSTALLATION OF ROOF DRAINS**

- A. General: Install roof drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Coordinate flashing work required with the General Contractor and with work of roofing, waterproofing and adjoining substrate work.
- C. Install roof drains at low points of surface areas to be drained, or as indicated.
- D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
- E. Position roof drains so that they are accessible and easy to maintain.

**END OF SECTION 22 14 13**

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## SECTION 22 15 16 - FACILITY NATURAL GAS AND COMPRESSED AIR PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
  - 1. Extent of natural gas piping work is indicated on drawings and schedules, and by requirements of this section.
  - 2. Installation of valves for natural gas piping system is specified in other Division-22 sections and is included as work of this section.
- B. Trenching and Backfill: Trenching and backfill required in conjunction with gas service piping is specified in applicable Division 22 sections and is included as work of this section.

#### 1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and install natural gas systems in accordance with NFPA 54 "National Fuel Gas Code".
- B. Utility Compliance: Fabricate and install natural gas systems in accordance with local gas utility company requirements.
- C. UPC Compliance: Fabricate and install natural gas systems in accordance with IAPMO "Uniform Plumbing Code".

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Pressure Regulator:
  - 1. Cashco
  - 2. Fisher
  - 3. Maxitrol
- B. Plug Valves
  - 1. Homestead
  - 2. Nordstrum
- C. Ball Valves
  - 1. Watts
  - 2. Nibco

- 3. Apollo
- 4. Milwaukee

D. Natural Gas and Compressed Air Outlets:

- 1. Fisher Hamilton/Water Saver

**2.2 BASIC MATERIALS AND PRODUCTS**

- A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with NFPA 54 where applicable; base pressure rating on natural gas piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in natural gas piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Piping Specialties: Refer to Section - 22 05 00 - Common Work Results for Plumbing.
- C. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

**2.3 PIPE:**

	<u>Material</u>	<u>Service</u>
A.	Black steel pipe Schedule 40, ASTM A53	Interior natural gas piping.
B.	Painted Black steel pipe Schedule 40, ASTM A53	Exterior natural gas piping.
C.	High Density Polyethylene (PE), PE3408 ASTM D2837, ASTM D3035	Exterior below grade gas piping.

**2.4 FITTINGS:**

- A. Steel Pipe:
  - 1. Threaded pipe (2" dia and smaller): Malleable iron fittings, 125 pound standard flat band water pattern.
  - 2. Welded pipe (2 1/2" dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.
- B. Polyethylene pipe fittings (gas service): Heat fusion fittings, provide fittings produced and recommended for the service indicated by manufacturer of piping.

## **2.5 JOINTS**

- A. Steel Pipe:
  - 1. Threaded pipe (2" dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore. For fuel piping and lubricating oil piping, joint sealing material shall be resistant to petroleum products.
  - 2. Welded pipe (2 1/2" dia and larger): Welding shall conform to welding section of ANSI-B31.3 "Code for Power Piping."
- B. Polyethylene pipe fittings (gas service): Heat fusion joints made in accordance with practices for the pipe service as recommended by manufacturer of piping.

## **2.6 NIPPLES AND UNIONS**

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type. For threaded brass pipe, use bronze ground joint unions with octagon ends.
- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
  - 1. In by-pass around equipment, valves, and controls.
  - 2. In connections to equipment.
  - 3. Where indicated on drawings.

## **2.7 VALVES**

- A. Natural Gas: 2" and smaller: Two-piece full-port bronze ball valve, suitable for natural gas service, threaded ends.
- B. Natural Gas: 2 1/2" to 6": Carbon steel or cast iron plug valve MSS SP-78, WOG (suitable for natural gas service) with flanged ends.
- C. Natural Gas Meter Valve: Provide with tamper-proof operator.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. General: Examine areas and conditions under which natural gas piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

### **3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS**

- A. General: Install basic materials and products as per manufacturer=s recommendations, Uniform Plumbing Code, local code requirements, Utility Company requirements and as required to meet the intent of the document.

B. Natural Gas Piping

1. Install pipe for all natural gas systems as indicated on drawings, as called for in other sections, and as specified herein.
2. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other natural gas items. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
3. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
4. Check all piping for interference with other trades; avoid placing pipes over electrical equipment.
5. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
6. Piping up to 2" diameter shall be screwed, piping 2-1/2" diameter and over shall be welded. Concealed gas piping shall be welded or otherwise installed as required per NFPA 54 and local code.
7. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.
8. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.
9. Install piping with 1/64" per foot (1/8%) downward slope in direction of flow.
10. Exposed outside pipe: Prime coat with appropriate lead oxide paint and apply finish enamel coat to match color of adjacent building material.

C. Valves

1. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.
2. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more natural gas terminals or equipment connections, and elsewhere as indicated.
3. Shutoff Valves: Install on inlet and outlet of each natural gas equipment item, and on inlet of each natural gas terminal, and elsewhere as indicated.
4. Drain Valves: Install on each natural gas equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain natural gas piping system.

D. Piping Specialties: Refer to Section 22 05 00 - Common Work Results for Plumbing.

E. Supports, Anchors and Seals: Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping.

F. Install specialties and accessories as indicated on drawings and in accordance with manufacturer's recommendations and applicable codes and standards.

### 3.3 INSTALLATION OF EQUIPMENT CONNECTIONS

A. General: Connect gas piping to each gas fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions.

**3.4 FIELD QUALITY CONTROL**

- A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility company requirements.

**3.5 ADJUSTING AND CLEANING**

- A. Cleaning and Inspecting: Clean and inspect natural gas systems in accordance with requirements of Division 22 Basic Mechanical Materials and Methods, Section 22 00 10 – Plumbing General Provisions.

**3.6 SPARE PARTS**

- A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

**END OF SECTION 22 15 16**

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## SECTION 22 15 17 - FACILITY FUEL-OIL PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Conditions are applicable to work required of this section.

#### 1.2 SUMMARY

- A. This Section includes fuel-oil distribution systems and the following:
  - 1. Pipes, tubes, and fittings.
  - 2. Piping and tubing joining materials.
  - 3. Piping specialties.
  - 4. Valves.
  - 5. Insulated, steel, fuel-oil ASTs.
  - 6. Fuel-oil storage tank piping specialties.
  - 7. Fuel-oil storage tank pumps.
  - 8. Fuel-transfer pumps.
  - 9. Liquid-level gage system.
  - 10. Leak-detection and monitoring system.
  - 11. Mechanical sleeve seals.

#### 1.3 DEFINITIONS

- A. AST: Aboveground storage tank.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- E. FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.
- F. FRP: Glass-fiber-reinforced plastic.
- G. UST: Underground storage tank.

#### 1.4 1.04 PERFORMANCE REQUIREMENTS

- A. Maximum Operating-Pressure Ratings: 3-psig fuel-oil supply pressure at oil-fired appliances.
- B. Delegated Design: Design restraint and anchors for fuel-oil piping, ASTs, and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

## **1.5 SUBMITTALS**

- A. **Product Data:** For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Also include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
1. Piping specialties.
  2. Valves: Include pressure rating, capacity, settings, and electrical connection data of selected models.
  3. Each type and size of fuel-oil storage tank. Indicate dimensions, weights, loads, components, and location and size of each field connection.
  4. Fuel-oil storage tank accessories.
  5. Fuel-oil storage tank piping specialties.
  6. Fuel-oil storage tank pumps.
  7. Fuel-oil transfer pumps.
  8. Liquid-level gage system.
  9. Leak-detection and monitoring system.
- B. **Shop Drawings:** For facility fuel-oil piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
1. Shop Drawing Scale: 1/4 inch per foot.
  2. For fuel-oil storage tanks and pumps, include details of supports and anchors.
- C. **Coordination Drawings:** Plans and details, drawn to scale, on which fuel-oil piping is shown and coordinated with other installations, using input from installers of the items involved.
- D. **Operation and Maintenance Data:** For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.
- E. **Warranty:** Sample of special warranty.

## **1.6 QUALITY ASSURANCE**

- A. **Steel Support Welding Qualifications:** Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. **Pipe Welding Qualifications:** Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. **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.
- D. **Comply with ASME B31.9, "Building Services Piping,"** for fuel-oil piping materials, installation, testing, and inspecting.
- E. **Comply with requirements of the EPA and of state and local authorities having jurisdiction.** Include recording of fuel-oil storage tanks and monitoring of tanks and piping.



## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store pipes and tubes with protective PE coating to avoid damaging the coating and to protect from direct sunlight.
- D. Store PE pipes and valves protected from direct sunlight.

## **1.8 PROJECT CONDITIONS**

- A. Interruption of Existing Fuel-Oil Service: Do not interrupt fuel-oil service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fuel-oil supply according to requirements indicated:
  - 1. Notify Owner no fewer than seven days in advance of proposed interruption of fuel-oil service.
  - 2. Do not proceed with interruption of fuel-oil service without Owner's written permission.

## **1.9 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

## **1.10 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-oil storage tanks and flexible, double-containment piping and related equipment that fail in materials or workmanship within specified warranty period.
  - 1. Storage Tanks:
    - a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:
      - 1) Structural failures including cracking, breakup, and collapse.
      - 2) Corrosion failure including external and internal corrosion of steel tanks.
    - b. Warranty Period: 30 years from date of Substantial Completion.
  - 2. Flexible, Double-Containment Piping and Related Equipment:
    - a. Failures due to defective materials or workmanship for materials installed together, including piping, dispenser sumps, entry boots, and sump mounting adapters.
    - b. Warranty Period: 30 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PIPES, TUBES, AND FITTINGS**

- A. See Part 3 piping schedule articles for where pipes, tubes, fittings, and joining materials are applied in various services.

- B. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
  3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    - a. Material Group: 1.1.
    - b. End Connections: Threaded or butt welding to match pipe.
    - c. Lapped Face: Not permitted underground.
    - d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
    - e. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.
  5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
    - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

## 2.2 DOUBLE-CONTAINMENT PIPE AND FITTINGS

- A. Flexible, Double-Containment Piping: Comply with UL 971.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Environ Products, Inc.
    - b. OPW.
  2. Pipe Materials: PVDF complying with ASTM D 3222 for carrier pipe with mechanical couplings to seal carrier, and PE pipe complying with ASTM D 4976 for containment piping.
  3. Fiberglass or PE sumps.
  4. Watertight sump entry boots, pipe adapters with test ports and tubes, coaxial fittings, and couplings.
  5. Minimum Operating Pressure Rating: 10 psig.
  6. Plastic to Steel Pipe Transition Fittings: Factory-fabricated fittings with plastic end matching or compatible with carrier piping, and steel pipe end complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  7. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.
- B. Rigid, Double-Containment Piping: Comply with UL 971.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ameron International; Fiberglass Pipe Group.
    - b. Conley Corporation.
    - c. Perma-Pipe, Inc.
    - d. Smith Fibercast.

2. RTRP: ASTM D 2996 or ASTM D 2997 carrier and containment piping and mechanical couplings to seal carrier and containment piping or individually bonded joints.
  - a. Minimum Operating-Pressure Rating for RTRP NPS 2 and NPS 3: 150 psig.
  - b. Minimum Operating-Pressure Rating for RTRP NPS 4 and NPS 6: 125 psig. Compliance with UL 971 is not required for NPS 6 and larger piping.
  - c. Fittings: RTRF complying with ASTM D 2996 or ASTM D 2997, and made by RTRP manufacturer; watertight sump entry boots, termination, or other end fittings.
3. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

### 2.3 PIPING SPECIALTIES

#### A. Flexible Connectors: Comply with UL 567.

1. Metallic Connectors:
  - a. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain first subparagraph and list of manufacturers below. See Division 01 Section "Product Requirements."
  - b. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) American Flexible Hose Co., Inc.
    - 2) Flexicraft Industries.
    - 3) FLEX-ING, Inc.
    - 4) Hose Master, Inc.
    - 5) Metraflex Company (The).
    - 6) Proco Products, Inc.
    - 7) Tru-Flex Metal Hose Corp.
    - 8) Unaflex.
  - c. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
  - d. Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
  - e. Minimum Operating Pressure: 150 psig.
  - f. End Connections: Socket, flanged, or threaded end to match connected piping.
  - g. Maximum Length: 30 inches.
  - h. Swivel end, 50-psig maximum operating pressure.
  - i. Factory-furnished anode.
2. Nonmetallic Connectors:
  - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) American Flexible Hose Co., Inc.
    - 2) Flexicraft Industries.
    - 3) FLEX-ING, Inc.
    - 4) Hose Master, Inc.
    - 5) Metraflex Company (The).
    - 6) Tru-Flex Metal Hose Corp.
  - b. Listed and labeled for underground applications by an NRTL acceptable to authorities having jurisdiction.

- c. PTFE bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
- d. Minimum Operating Pressure: 150 psig.
- e. End Connections: Socket, flanged, or threaded end to match connected piping.
- f. Maximum Length: 30 inches.
- g. Swivel end, 50-psig maximum operating pressure.
- h. Factory-furnished anode.

B. Y-Pattern Strainers:

- 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
- 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
- 3. Strainer Screen: 80-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

C. Manual Air Vents:

- 1. Body: Bronze.
- 2. Internal Parts: Nonferrous.
- 3. Operator: Screwdriver or thumbscrew.
- 4. Inlet Connection: NPS 1/2.
- 5. Discharge Connection: NPS 1/8.
- 6. CWP Rating: 150 psig.
- 7. Maximum Operating Temperature: 225 deg F.

## 2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for fuel oil.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

## 2.5 MANUAL FUEL-OIL SHUTOFF VALVES

- A. See valve schedule in Part 3 for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with UL 842.
  - 1. CWP Rating: 125 psig.
  - 2. Threaded Ends: Comply with ASME B1.20.1.
  - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  - 4. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
  - 5. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with UL 842.
  - 1. CWP Rating: 125 psig.
  - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  - 3. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.

4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Apollo Valves
    - b. Lyall, R. W. & Company, Inc.
    - c. McDonald, A. Y. Mfg. Co.
    - d. Perfection Corporation; A Subsidiary of American Meter Company.
  2. Body: Bronze, complying with ASTM B 584.
  3. Ball: Chrome-plated bronze.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE; blowout proof.
  6. Packing: Threaded-body packnut design with adjustable-stem packing.
  7. Ends: Threaded, flared, or socket as indicated in the valve schedule.
  8. CWP Rating: 600 psig.
  9. Service Mark: Initials "WOG" shall be permanently marked on valve body.

## 2.6 SPECIALTY VALVES

- A. Pressure Relief Valves: Comply with UL 842.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Anderson Greenwood; Division of Tyco Flow Control.
    - b. Fulflo Specialties, Inc.
    - c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
  2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
  3. Body: Brass, bronze, or cast steel.
  4. Springs: Stainless steel, interchangeable.
  5. Seat and Seal: Nitrile rubber.
  6. Orifice: Stainless steel, interchangeable.
  7. Factory-Applied Finish: Baked enamel.
  8. Maximum Inlet Pressure: 150 psig.
  9. Relief Pressure Setting: 60 psig.
- B. Oil Safety Valves: Comply with UL 842.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Anderson Greenwood; Division of Tyco Flow Control.
    - b. Suntec Industries Incorporated.
    - c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
  2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
  3. Body: Brass, bronze, or cast steel.

4. Springs: Stainless steel.
5. Seat and Diaphragm: Nitrile rubber.
6. Orifice: Stainless steel, interchangeable.
7. Factory-Applied Finish: Baked enamel.
8. Manual override port.
9. Maximum Inlet Pressure: 60 psig.
10. Maximum Outlet Pressure: 3 psig.

C. Emergency Shutoff Valves: Comply with UL 842.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Ameron International; Fiberglass Pipe Group.
  - b. Conley Corporation.
  - c. EMCO Wheaton; a Gardner Denver Company.
  - d. Environ Products, Inc.
  - e. OPW.
2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3. Body: ASTM A 126, cast iron.
4. Disk: FPM.
5. Poppet Spring: Stainless steel.
6. Stem: Plated brass.
7. O-Ring: FPM.
8. Packing Nut: PTFE-coated brass.
9. Fusible link to close valve at 165 deg F.
10. Thermal relief to vent line pressure buildup due to fire.
11. Air test port.
12. Maximum Operating Pressure: 0.5 psig.

D. Mechanical Leak Detector: Comply with UL 842.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. FE Petro, Inc.
  - b. Red Jacket Pumps; a division of Veeder-Root.
3. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
4. Body: ASTM A 126, cast iron.
5. O-Rings: Elastomeric compatible with fuel oil.
6. Piston and Stem Seals: PTFE.
7. Stem and Spring: Stainless steel.
8. Piston Cylinder: Burnished brass.
9. Indicated Leak Rate: Maximum 3 gph at 10 psig.
10. Leak Indication: Reduced flow.

## **2.7 INSULATED, STEEL, FUEL-OIL AST**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Ace Tank & Equipment Company.
  - 2. Adamson Global Technology Corporation.
  - 3. Areo Power Unitized Fueler Inc.
  - 4. Brown Tank.
  - 5. Containment Solutions, Inc.
  - 6. ConVault, Inc.
  - 7. Hamilton Tanks.
  - 8. Highland Tank & Manufacturing Company, Inc.
  - 9. Modern Welding Company, Inc.
  - 10. Palmer Manufacturing & Tank Inc.
  - 11. Steel Tank & Fabricating Co., Inc.
  - 12. We-Mac Manufacturing, Inc.
- B. Description: UL 142, UL 2085, and STI F941, thermally insulated and fire-resistant, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.
- C. Construction: Fabricated with welded, carbon steel and insulation; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.

## **SHOP PAINTING OF AST**

- A. Apply manufacturer's standard prime coat to exterior steel surface of AST and supports.
- B. Prepare exterior steel surface of AST and tank supports.
- C. Shop Cleaning: After fabrication, blast clean according to SSPC-SP 6/NACE No. 3.
- D. After cleaning, remove dust or residue from cleaned surfaces.
- E. If surface develops rust before prime coat is applied, repeat surface preparation.
- F. Apply manufacturer's standard prime coat to shop-cleaned, dry surface same day as surface preparation.
- G. Apply manufacturer's standard two-component, epoxy finish coats.

## **2.9 FUEL-OIL AST ACCESSORIES**

- A. Tank Manholes: 22-inch- minimum diameter; bolted, flanged, and gasketed; centered on top of tank.
- B. Tank Manholes: 22-inch- minimum diameter; bolted, flanged, and gasketed; on top and at side of tank.
- C. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.

- D. Threaded pipe connection fittings on top or sides of tank as indicated, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
- E. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
- F. Lifting Lugs: For handling and installation.
- G. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom, and located as indicated. Include reinforcement of tank at bottom of ladder.
- H. Ladders: Carbon-steel ladder outside tank, anchored to top and side wall. Comply with requirements in Division 05 Section "Metal Fabrications" for exterior steel ladder.
  - 1. Cage: Include welded steel cage around ladders for tanks 20 feet high or higher.
- I. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
- J. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

## **2.10 SUBMERSIBLE FUEL-OIL PUMPS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. FE Petro, Inc.
  - 2. Red Jacket Pumps; a division of Veeder-Root.
- B. Description: Comply with UL 79, UL 87, and UL 343.
  - 1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
  - 2. Impeller: Turbine.
  - 3. Housing and Volute: Cast iron.
  - 4. Bearings: Bronze, self-lubricating.
  - 5. Seals: Mechanical.
  - 6. Shaft: Polished steel.
  - 7. Suspension Piping: Telescoping to accommodate tank diameter and depth of bury.
  - 8. Base: Steel.
  - 9. Pressure Relief: Built in.
  - 10. Discharge Check Valve: Built in.
  - 11. Drive: Direct, close coupled.
- C. Controls: Pump controller panel complying with UL 353 and UL 508C and with interlock and terminals for connections to diesel-driven emergency generators.
  - 1. Run pumps to maintain minimum manifold pressure with outdoor-air temperature less than 60 deg F.
  - 2. Run pumps on seven-day schedule.
  - 3. Stage pumps on pressure at a common supply manifold.
  - 4. Alternate pumps to equalize run time.
  - 5. Alarm motor failure.
  - 6. Manual reset dry-run protection. Stop pumps if fuel level falls below pump suction.



7. Deenergize and alarm pump locked rotor condition.
  8. Alarm open circuit, high and low voltage.
  9. Indicating lights for power on, run, and off normal conditions.
  10. Interface with automatic control system is specified in Division 23, Section 23 0900 – Building Automation System (BAS), to control and indicate the following:
    - a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions.
    - b. Operating status.
    - c. Alarm off-normal status.
- D. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  2. Thermal-Overload Protection: Motor-winding temperature sensor.
  3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

## 2.11 LIQUID-LEVEL GAGE SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Caldwell Systems Corporation.
  2. Clawson Tank Company.
  3. EBW, Inc.
  4. Highland Tank & Manufacturing Company, Inc.
  5. INCON, Inc.
  6. King Engineering Corp.
  7. Krueger Sentry Gauge.
  8. Pneumercator Inc.
  9. Preferred Utilities Manufacturing Corporation.
  10. Rochester Gauges, Inc.
  11. Tuthill Corporation; Tuthill Transfer Systems; Sotera Systems.
  12. Uehling Instrument Company.
  13. Venture Measurement Company, LLC.
- B. Description: Calibrated, liquid-level gage system complying with UL 180 with floats or other sensors and remote annunciator panel.
- C. Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
- D. Controls: Electrical, operating on 120-Vac.

## 2.12 LEAK-DETECTION AND MONITORING SYSTEM

- A. Cable and Sensor System: Comply with UL 1238.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Caldwell Systems Corporation.
    - b. Containment Solutions, Inc.
    - c. EBW, Inc.
    - d. Gems Sensors Inc.
    - e. Highland Tank & Manufacturing Company, Inc.
    - f. INCON, Inc.
    - g. In-Situ, Inc.
    - h. MSA; Instrument Div.
    - i. Perma-Pipe, Inc.
    - j. Pneumercator Inc.
    - k. Raychem Corp; Tyco Electronics Corporation.
    - l. Tuthill Corporation; Tuthill Transfer Systems; Sotera Systems.
    - m. Veeder-Root; a Danaher Corporation Company.
  2. Calibrated, leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
  3. Include fittings and devices required for testing.
  4. Controls: Electrical, operating on 120-V ac.
  5. Calibrated, liquid-level gage complying with UL 180 with floats UL 1238 with probes or other sensors and remote annunciator panel.
  6. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
  7. Controls: Electrical, operating on 120-V ac.
- B. Hydrostatic System: Comply with UL 1238.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Caldwell Systems Corporation.
    - b. Containment Solutions, Inc.
    - c. EBW, Inc.
    - d. Gems Sensors Inc.
    - e. Highland Tank & Manufacturing Company, Inc.
    - f. INCON, Inc.
    - g. In-Situ, Inc.
    - h. MSA; Instrument Div.
    - i. Perma-Pipe, Inc.
    - j. Pneumercator Inc.
    - k. Raychem Corp; Tyco Electronics Corporation.
    - l. Tuthill Corporation; Tuthill Transfer Systems; Sotera Systems.
    - m. Veeder-Root; a Danaher Corporation Company.
  2. Calibrated, leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls.

3. Include fittings and devices required for testing.
4. Controls: Electrical, operating on 120-V ac.
5. Calibrated, liquid-level gage complying with UL 180 with floats, UL 1238 with probes or other sensors and remote annunciator panel.
6. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
7. Controls: Electrical, operating on 120-V ac.

### **2.13 SLEEVES**

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

### **2.14 MECHANICAL SLEEVE SEALS**

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico Inc.
    - c. Metraflex Company (The).
    - d. Pipeline Seal and Insulator, Inc.
    - e. Insert manufacturer's name.
  2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
  3. Pressure Plates: Carbon steel.
  4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

### **2.15 ESCUTCHEONS**

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube and with OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn brass with polished chrome-plated finish.

### **2.16 LABELING AND IDENTIFYING**

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

## **2.17 SOURCE QUALITY CONTROL**

- A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, according to ASME and the following:
  - 1. Double-Wall Steel ASTs: UL 142, STI F921, and STI R931.
  - 2. Horizontal, Containment-Dike, Steel ASTs: UL 142 and STI F911.
  - 3. Horizontal, Steel ASTs: UL 142 and UL 2085.
- B. Affix standards organization's code stamp.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine roughing-in for fuel-oil piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 EARTHWORK**

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

### **3.3 PREPARATION**

- A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
- B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

### **3.4 OUTDOOR PIPING INSTALLATION**

- A. Install underground fuel-oil piping buried at least **24** inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
- B. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer. Review protective coating damage with Design Professional prior to repair.
  - 3. Replace pipe having damaged PE coating with new pipe.
- C. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fuel-oil storage tank sump.
- D. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.
- E. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquid-tight joints.
- F. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST and UST.

- G. Install fittings for changes in direction in rigid pipe.
- H. Install system components with pressure rating equal to or greater than system operating pressure.
- I. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- J. Mechanical Sleeve Seal Installation: Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- K. Install pressure gage on suction from each pump. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

### **3.5 INDOOR PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations.
- B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install escutcheons for penetrations of walls, ceilings, and floors in finished spaces.
- I. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- J. Verify final equipment locations for roughing-in.
- K. Comply with requirements for equipment specifications in Division 22 and Division 23 Sections for roughing-in requirements.
- L. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.
- M. Prohibited Locations:
  - 1. Do not install fuel-oil piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

- 2. Do not install fuel-oil piping in solid walls or partitions.
- N. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- O. Connect branch piping from top or side of horizontal piping.
- P. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.
- Q. Do not use fuel-oil piping as grounding electrode.
- R. Install Y-pattern strainer on inlet side of fuel-oil pump.

### **3.6 VALVE INSTALLATION**

- A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.
- B. Install valves in accessible locations.
- C. Protect valves from physical damage.
- D. Install metal tag attached with metal chain indicating fuel-oil piping systems.
- E. Identify valves as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- F. Install oil safety valves at inlet of each oil-fired appliance.
- G. Install pressure relief valves in distribution piping between the supply and return lines.
- H. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.
- I. Install manual air vents at high points in fuel-oil piping.
- J. Install emergency shutoff valves at dispensers.

### **3.7 PIPING JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.
  - 1. Bevel plain ends of steel pipe.
  - 2. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.
- G. Flared Joints: Comply with SAE J513. Tighten finger tight, then use wrench according to fitting manufacturer's written recommendations. Do not overtighten.
- H. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### **3.8 FUEL-OIL AST INSTALLATION**

- A. Install tank bases and supports.
- B. Connect piping and vent fittings.
- C. Install ground connections.
- D. Install tank leak-detection and monitoring devices.
- E. Install steel ASTs according to STI R912.
- F. Install insulated and concrete-vaulted, steel ASTs according to STI R942.
- G. Fill storage tanks with fuel oil.

### **3.9 HANGER AND SUPPORT INSTALLATION**

- A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

### **3.10 FUEL-OIL PUMP INSTALLATION**

- A. Submersible Pumps:
  - 1. Suspend pumps from supply piping and anchored to bottom of tank.
- B. Transfer Pumps:
  - 1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
  - 2. Set pumps on and anchor to concrete base.
- C. Install two-piece, full-port ball valves at suction and discharge of pumps.

- D. Install mechanical leak-detector valves at pump discharge.
- E. Install Y-pattern strainer on inlet side of simplex fuel-oil pumps.
- F. Install check valve on discharge of simplex fuel-oil pumps.
- G. Install suction piping with minimum fittings and change of direction.
- H. Install vacuum and pressure gage, upstream and downstream respectively, at each pump to measure the differential pressure across the pump. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

### **3.11 FUEL MAINTENANCE SYSTEM INSTALLATION**

- A. Install suction line, with foot valve, at one end of storage tank, 1 inch from the bottom of tank.
- B. Install return line at the opposite end of storage tank from suction line.

### **3.12 LIQUID-LEVEL GAGE SYSTEM INSTALLATION**

- A. Install liquid-level gage system. Locate panel inside building where indicated.

### **3.13 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION**

- A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.
  1. Double-Wall, Fuel-Oil Storage Tanks: Install probes or use factory-installed integral probes in interstitial space.
  2. Double-Containment, Fuel-Oil Piping: Install leak-detection sensor cable probes in interstitial space of double-containment piping.
  3. Install liquid-level gage.

### **3.14 CONNECTIONS**

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
- C. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
- D. Connect piping to equipment with ball valve and union. Install union between valve and equipment.
- E. Install flexible piping connectors at final connection to burners or oil-fired appliances that must be moved for maintenance access.

### **3.15 LABELING AND IDENTIFYING**

- A. Nameplates, pipe identification, and signs are specified in Division 23 Section "Identification for HVAC Piping and Equipment."



- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator, service meter, and earthquake valve.
  - 1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Install detectable warning tape directly above fuel-oil piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Terminate tracer wire in an accessible area, and identify as "tracer wire" for future use with plastic-laminate sign.
  - 1. Piping: Over underground fuel-oil distribution piping.
  - 2. Fuel-Oil Storage Tanks: Over edges of each UST.

## FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:
    - a. Double-Wall Tanks:
      - 1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
      - 2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.
    - b. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
    - c. Maintain the test pressure for one hour.
  - 2. Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:
    - a. Fuel-Oil Distribution Piping: Minimum 5 psig for minimum 30 minutes.
    - b. Fuel-Oil, Double-Containment Piping:
      - 1) Carrier Pipe: Minimum 5 psig for minimum 30 minutes.
      - 2) Containment Conduit: Minimum 5 psig for minimum 60 minutes.
    - c. Suction Piping: Minimum 20-in. Hg for minimum 30 minutes.
    - d. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig.
  - 3. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.
  - 4. Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than three different depths while filling tank and checking against gage indication.

5. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.
  6. Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks.
  7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  8. Bleed air from fuel-oil piping using manual air vents.
- D. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.17 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain liquid-level gage systems, leak-detection and monitoring systems, and fuel-oil pumps.

### **3.18 OUTDOOR PIPING SCHEDULE**

- A. Underground fuel-oil piping shall be one of the following. Size indicated is carrier-pipe size.
1. Flexible, double-containment piping.
  2. Rigid, double-containment piping.
- B. Underground fuel-oil-tank fill and vent piping shall be the following:
1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints. Coat pipe and fittings with protective coating for steel piping.
  2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints. Coat pipe and fittings with protective coating for steel piping.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- D. Aboveground fuel-oil piping shall be the following:
1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
  2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

### **3.19 INDOOR PIPING SCHEDULE**

- A. Aboveground fuel-oil piping shall be the following:
1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
  2. NPS 2-1/2 and Larger: Steel pipe, steel fittings, and welded or flanged joints.
  3. Steel pipe with malleable-iron fittings and threaded joints.
  4. Steel pipe with wrought-steel fittings and welded joints.

**3.20 ABOVEGROUND MANUAL FUEL-OIL SHUTOFF VALVE SCHEDULE**

- A. Distribution piping valves for pipe NPS 2 and smaller shall be the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Distribution piping valves for pipe NPS 2-1/2 and larger shall be the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- C. Valves in branch piping for single appliance shall be the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.

**END OF SECTION 22 15 17**

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## SECTION 22 31 00 - DOMESTIC WATER SOFTENERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of plumbing equipment work is indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.
- B. Types of plumbing equipment required for project include the following:
  - 1. Water Softeners

#### 1.3 QUALITY ASSURANCE

- A. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- B. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.
- C. ANSI/NSF 372 Certification: Domestic Water Softeners shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start up instructions, and capacity and ratings, with selection points clearly marked.
- B. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.

#### 1.5 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 00, Commissioning, for detailed commissioning requirements.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Water Softeners
  - 1. Culligan

## 2.2 WATER SOFTENERS

- A. General: Furnish, install, and place in operation an Automatic Water Softener System of capacities and performance as scheduled.
- B. Tanks: Softener tank(s) shall be of welded construction of tank quality carbon steel. The tank(s) shall have reinforced openings for pipe connections and a manhole in the top head. The tank(s) shall be rated for 100 psig working pressure and 150 psig test pressure. Support legs will be the strap-type permanently welded to the lower tank head. The tank(s) shall have baked phenolic internal lining 4-5 mils DFT, with rust resistant prime coat 2-3 mils DFT. Interior shall be a minimum freeboard of 50% for backwash expansion above the normal ion exchange resin bed level.
- C. Upper Distributor: The upper distribution system shall be a single point baffle constructed of stainless steel galvanized steel pipe and fittings.
- D. Lower Distributor: The lower distribution system shall be of the hub end radial type constructed of Schedule-80 PVC with slotted full flow non-clogging replaceable polypropylene strainers.
- E. Brine System: A combination salt storage and brine measuring tank constructed of fiberglass reinforced plastic. The tank shall be equipped with a drain port near the bottom for periodic tank cleanout and an overflow connection near the top. The brine system will include a distributor in the bottom on the brine tank for collecting brine and a chamber for housing an automatic air eliminator. The brine system will automatically open to inject brine in the softener, close to prevent the entrance of air, and refill the brine tank with the proper amount of water. Brine dosage will be regulated by adjustment of a salt dosage dial in the timeclock case. The system will be designed to allow proper refilling regardless of salt level in the brine tank. In addition to the solenoid controlled shut-off, the brine system will include a float operated shut-off to prevent brine tank overflow.
- F. Automatic Controls: The automatic control will be of top mount design, all-brass construction with bolt-down flange connection. Control valve shall allow for either left-hand or right-hand connections. The control shall be fully automatic multi-port control valve operated by a rotary pilot that hydraulically or pneumatically activates cartridge style diaphragm valves for regeneration. The multi-port valve will incorporate self-adjusting flow regulators to control the rate of flow during backwash and brine-rinse and fast rinse positioners, regardless of pressure fluctuations between 30 and 100 psi. The control will open and close slowly to prevent noise and hydraulic shock. The system shall prevent hard water by-pass during the regeneration cycle.
- G. The electrical control mechanism shall be provided in a gasketed, moisture-resistant case, NEMA 3R enclosure. The unit will have provisions for individual adjustment of backwash and rinse cycle, and provisions for manually regenerating the water filter by means of inlet hydraulic pressure. Regeneration will be demand based controlled by an aqua-sensor that operates regeneration cycles.
- H. Controller:
  - 1. A fully integrated programmable micro-processor driven electronic controller shall be provided to automatically cycle the main operating valve through the reconditioning sequence.

2. The controller shall be capable of initiating a reconditioning by accepting an internal signal from the controller time keeping device; an external Hall-Effect flow sensor, a differential pressure switch, an external device such as a remote start push-button or a combination of these methods. The controller shall sequence all steps of an automatic reconditioning and automatically return the filter to a service or stand-by mode. The initiating time and/or volume setpoints shall automatically reset upon initiation of the reconditioning sequence.
  3. The controller shall include a sealed keypad, capable of programming all controller functions, located on the face of the controller. The controller display shall be a backlit LCD type with six-12 segment alphanumeric characters and icons. A standby status indicator LED shall indicate when a control is in a standby mode.
  4. An audible alarm beeper capable of emitting a tone of ~70 dBA shall be available but capable of being disabled if so desired.
  5. The controller shall allow for a manual initiation of the automatic regeneration sequence by utilizing a regeneration button on the face of the controller.
  6. The controller shall operate on a low voltage electrical system. The system shall include a UL/CUL listed transformer. The entire electronic control package and its associated inputs/outputs shall require not more than 24 VAC @ 50VA.
  7. The multi-ported pilot control assembly shall include a dial for visual indication of the system status; the pilot control valve shall also allow manual operation in the event of a power failure.
  8. The controller shall utilize EEPROM to save pertinent programmed data and statistical functions. The controller must retain all functionality for power interruptions of less than 12 hours. A battery backup shall be available as an add on option capable of maintaining the time of day for a minimum of 4 weeks.
  9. Duplex Progressive Control: One controller shall be dedicated as the primary controller. This controller shall be programmed with a trip point to bring an additional tank to an on line status from standby once the treated water flow demand of the facility meets the trip point flow rate. The additional tank shall be returned to a standby status once the treated water flow demand is less than the trip point flow rate for a minimum of 60 seconds.
  10. Provide RS485 multiple unit communication input/output between units. Controllers shall sequence regeneration cycles to prohibit simultaneous regeneration.
- I. Flow Control: An automatic backwash control shall be provided to maintain a proper backwash and fast flush flows over wide variations of operating pressure. Controller to contain no moving parts, and require no field adjustment. The flow controls shall be manufactured by the same manufacturer as the entire softening system.
- J. Piping: Manufacturer to furnish softener tank, with assembled valve manifold piping. Contractor shall furnish and install interconnecting piping. Drain shall have an air gap conforming to local codes to permit observation of discharge backwash water and manufacturer shall provide a valved drain at the lowest point of the softener system.
- K. Provide the following accessories:
1. Inlet and outlet gauges with isolation valves.
  2. Valved drain at lowest point of softener system.

**PART 3 - EXECUTION**

**3.1 INSTALLATION OF WATER SOFTENER**

- A. General: Install water softener as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.
  - 1. Set water softener in indicated location; connect to inlet, outlet and drain piping.
  - 2. Start up: Start up, test, and adjust water softener in accordance with manufacturer's start up instructions. Check and adjust controls for proper operation.

**END OF SECTION 22 36 00**



## SECTION 22 3400 - FUEL-FIRED DOMESTIC WATER HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of plumbing equipment work is indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.
- B. Types of plumbing equipment required for project include the following:
  - 1. Tank Style Gas-fired Water Heaters
  - 2. Condensing Tankless Gas-fired Water Heater

#### 1.3 QUALITY ASSURANCE

- A. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- B. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.
- C. ANSI Compliance: Comply with ANSI Z223.1 (NFPA 54) “National Fuel Gas Code”, as applicable to installation of gas fired water heaters.
- D. AGA Labels: Provide water heaters which have been listed and labeled by American Gas Association.
- E. ANSI/NSF 372 Certification: Fuel-Fired Domestic Water Heaters shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer’s plumbing equipment specifications, installation and start up instructions, and capacity and ratings, with selection points clearly marked.
- B. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Residential Gas fired Water Heaters
  - 1. A.O. Smith, Consumer Products Div.

2. Rheem-Ruud
3. State Industries

B. Condensing Tankless Gas-fired Water Heaters

1. Navien
2. Rinnai
3. Rheem

## 2.2 WATER HEATERS

A. Residential Gas fired Water Heaters

1. General: Provide gas fired water heaters of size and capacity as indicated on schedule. Comply with ANSI/ASHRAE/IES 90A for energy efficiency.
2. Heater: Working pressure of 150 psi; 3/4" tapping for relief valve; magnesium anode rod; glass lining on internal surfaces exposed to water.
3. Safety Controls: Equip with automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank; and pilot safety shutoff.
4. Combustion System: Equip with power venting system certified for power direct venting up to 40 equivalent feet on the intake vent arrangement and up to 40 equivalent feet on the exhaust vent arrangement, using standard PVC, class 160, schedule 40 or CPVC vent piping. Gravity direct vented or heaters that use room air for combustion are not acceptable equals. The water heater shall include a 6' plug-in power cord and provision for direct connection to a standard electrical outlet. Blower shall include pressure switches which will shut down power to the burner in case of vent system failure due to down drafts or vent blockage.
5. Jacket: Provide outer steel jacket with tank insulation and baked enamel finish.
6. Warranty: Furnish 1 year limited warranty for tank leakage.
7. Accessories: Provide brass drain valve; 3/4" relief valve; cold water dip tube.
8. Controls: Provide gas pressure regulator; pilot gas regulator adjustable thermostat.

B. Condensing Tankless Gas-fired Water Heaters

1. General: Provide commercial gas fired water heaters of size and capacity as indicated on schedule. Comply with ANSI/ASHRAE/IES 90A for energy efficiency. Provide certification of design by CSA under Volume III tests for commercial water heaters for delivery of 180 degrees F (82 degrees C) water. Water heater pressure vessel shall be constructed and tested in accordance with Section IV HLW of the ASME Pressure Vessel Code.
2. Water heater shall be of gas fired, condensing fire tube design with a modulating power burner and positive pressure discharge. Burner shall be capable of 14:1 turndown of firing rate without loss of combustion efficiency. Heat exchanger/combustion chamber shall incorporate a helical fire tube design that will be self supporting, baffle free, and warranted to withstand thermal shock.
3. Heat exchanger shall be ASME stamped for a working pressure of not less than 150 psig. Unit shall have an ASME approved temperature/pressure relief valve with a setting of 150 psig.
4. Exhaust manifold shall be of corrosion resistant porcelain enameled cast iron, with a 6" diameter flue connection. Exhaust manifold shall have a gravity drain for the elimination of condensation.
5. The flame monitoring system shall incorporate a UL recognized combustion safeguard system utilizing interrupted spark ignition and a rectification type flame sensor. An electrohydraulic double seated safety shutoff valve shall be an inherent part of the gas train.

6. Water heater shall incorporate electric probe type low water cutoff and dual over temperature protection including a manual reset in accordance with ASME and CSD-1. Remote fault alarm contacts and sensor failure detection shall be standard equipment.
7. Warranty: Pressure vessel shall carry an unconditional 10-year warranty against leakage due to defects in materials or workmanship or corrosion. The heat exchanger tubes/combustion chamber assembly shall be warranted against failure due to thermal stress failure or condensate corrosion for a prorated five-year period.
8. Accessories: Provide brass drain valve; 3/4" pressure and temperature relief valve; radiant floor shield.
9. Controls: Heater shall include integral factory wired operating controls to control all operation and energy input. Control of discharge water temperature shall be set through an internal setpoint with a field adjustment of 100F to 200F. Unit shall maintain discharge temperature within specified range through domestic water flow variations from 0 to 100%. Heater shall be capable of maintaining the outlet temperature within an accuracy of +/-4F.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF WATER HEATERS**

##### **A. Gas fired Water Heaters**

1. General: Install gas fired water heaters as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.
2. Support: Set units and orient so controls and devices needing service and maintenance have adequate access. Level and plumb unit.
3. Gas Supply: Connect to gas line with drip leg, tee, gas cock and union; full size of unit inlet connection. Locate piping so as not to interfere with service of unit.
4. Piping: Connect hot and cold water piping to units with shutoff valves and unions.
5. Flue/Intake: Install according to manufacturer's recommendations to be consistent with sealed system or draft hood.
6. Start Up: Start up, test and adjust gas fired water heaters in accordance with manufacturer's start up instructions, and Utility Company's requirements. Check and calibrate controls, adjust burner for maximum efficiency.
7. Pressure and Temperature Relief: Route pipe to nearest indirect sanitary drain. Pipe size to match relief connection size.

**END OF SECTION 22 34 00**

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## SECTION 22 40 00 - PLUMBING FIXTURES

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary for the plumbing fixture installation as required by the drawings and this section.
- B. Fixtures, trim and accessories shall be of type and model numbers as scheduled on the drawings.

#### 1.3 SUBMITTALS

- A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough in dimensions, and construction material for each type of fixture, trim and accessory scheduled.
- B. Furnish rough-in information that impacts other trades to General Contractor for distribution to other sub-contractors. This includes, but is not limited to, sink cut out templates, shower/tub framing dimension drawings, electrical power rough-in dimension drawings, etc.

#### 1.4 QUALITY ASSURANCE

- A. ANSI/NSF 372 Certification: All potable water supply piping and valves shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Refer to schedules on plans for basis of design plumbing fixtures. All other manufacturers must submit a substitution request for approval prior to bidding.
- B. Vitreous China and Cast Iron Enameled Fixtures
  - 1. American Standard
  - 2. Kohler
  - 3. Zurn
  - 4. Sloan
- C. Stainless Steel Sinks
  - 1. Elkay
  - 2. Just
  - 3. Kohler
  - 4. Franke

- D. Trim
  - 1. American Standard
  - 2. Chicago Faucet
  - 3. Delta
  - 4. Elkay
  - 5. Kohler
  - 6. T & S Brass Works
  - 7. Sloan
  
- E. Flush Valves
  - 1. Sloan - Royal Series
  - 2. Zurn – Aquavantage Series
  
- F. Carriers
  - 1. Jay R. Smith
  - 2. Josam
  - 3. Wade
  - 4. Watts
  - 5. Zurn
  
- G. Valve Boxes
  - 1. Guy Gray
  
- H. Fiberglass Tub and Shower Modules
  - 1. Aquarius
  - 2. Oasis
  - 3. Aquatic
  - 4. Best Bath
  
- I. Shower Valves
  - 1. Leonard
  - 2. Symmons
  - 3. Delta
  - 4. Kohler
  - 5. Bradley
  
- J. Mop Sinks and Laundry Tubs
  - 1. Fiat
  - 2. Mustee
  - 3. Pro Flo
  
- K. Thermostatic Mixing Valves
  - 1. Leonard
  - 2. Powers
  - 3. Symmons
  - 4. Apollo

- 5. Lawler
- L. Digital Mixing Valves
  - 1. Armstrong
  - 2. Leonard
  - 3. Powers
- M. Garbage Disposals
  - 1. In-Sink-Erator
- N. Wall Hydrants
  - 1. Woodford
  - 2. Prier
  - 3. JR Smith
- O. Hose Thread Vacuum Breakers
  - 1. Watts
  - 2. Zurn Wilkins
  - 3. Apollo

## **2.2 VITREOUS AND CAST IRON FIXTURES**

- A. Vitreous ware shall be non absorbant, even color, unwarped, two fired vitreous china, grade "A" as rated by the Bureau of Standards.
- B. Enameled cast iron fixtures shall have the enamel fused with the iron to provide a hard acid resisting enameled finish.
- C. Vitreous and enamel fixtures shall be white, except where other colors are called for in the schedule.
- D. Bath tubs shall have slip resistant surface.
- E. Fiberglass, gel-coat fixtures shall incorporate Microban antimicrobial protection.

## **2.3 STAINLESS STEEL SINKS**

- A. Stainless steel sinks shall be fabricated from 18 gauge nickel bearing type 302 stainless steel, with satin finish, sound deadening treatment and 3/16" drop down ledge. Provide with channel and pull down clips to ensure tight seal between sink and countertop.

## **2.4 ACCESSORIES**

- A. Accessories to include supply pipes, stop valves, faucets, tail pieces, strainers, waste and traps. Floor and wall plates shall be brass. Exposed accessories shall be chrome plated.
- B. Potable water supply piping and fixtures and associated accessories (excluding toilets, urinals, fill valves, flush valves, and shower valves) shall meet the certification requirements of ANSI/NSF 372 – Drinking Water System Components, Lead Content.

- C. Stop valves shall be compression type with loose key control.
- D. P-trap shall be adjustable 18 gauge tubular brass. Where offset P-traps are required for handicapped accessible lavatories, offset and P-trap shall be insulated with Handi Lav-Guard by Truebro, or equal. When supply risers are exposed, they shall be insulated with Handi Lav-Guard by Truebro, or equal.
- E. Accessories shall be considered "exposed" even when concealed behind base cabinets having doors.
- F. Mixing valve, transformer, or piping under the counter shall be covered with Lav-Shield by Truebro or equal in areas where a cabinet does not cover them.
- G. Water closet fixture carriers shall be heavy duty type with a minimum weight rating of 500 lbs.

## **2.5 VALVE BOXES**

- A. Box material shall be PVC High temperature Resin with Intumescent pad for to achieve fire rating required to match rating of wall where box is shown on plans. Snap on frame shall accommodate up to two layers of 5/8" drywall.
- B. Valves shall be included as indicated in Plumbing Fixture Schedule on the plans. All valves for domestic hot or cold water shall be lead free and comply with NSF/ANSI 372 (annex G) and the US Safe Drinking Water Act.
- C. Accessories: Provide other accessories as indicated in the Plumbing Fixture Schedule on the plans.

## **2.6 DIGITAL MIXING VALVE**

- A. Temperature controller shall be controlled digitally via integrated circuit board technology designed to deliver blended water at a safe, accurate temperature. The mixing valve shall have a 2 line, 16 character display of delivered temperature with the option of deg. F or deg. C. Display shall also show the error codes and alarm conditions. The temperature controller shall be compliant with ASSE Standard 1017, CSA B125 and CE. Unit shall have lead free stainless steel/polymer, brass or bronze body construction.
- B. General Performance:
  - 1. The maximum water pressure drop shall not exceed 10 psi.
  - 2. Outlet water temperature shall be controlled to within plus or minus 2 deg. F.
  - 3. Operational water pressure shall be 20-125 psig.
  - 4. Automatic shutoff of hot water flow upon cold water inlet supply failure.
  - 5. Automatic shutoff of hot water flow in the event of power failure.
  - 6. Programmable set point range of 100-158 deg. F.
  - 7. Programmable 1st level hi/lo temperature alarm display.
  - 8. Installation shall include a balancing valve with visible flow meter on circulated hot water side, Caleffi Model 132 or equal.
- C. Digital Mixing Center: Shall consist of quantity of mixing valves in pre-piped arrangement required to provide temperature control over full range from 0.5 gpm to peak flow indicated on drawings, including isolation valves, strainers, and check valves. All piping, fittings and valves in pre-piped assembly shall meet requirements of other plumbing specifications. Complete assembly shall be lead free compliant.



## **2.7 HOSE THREAD VACUUM BREAKERS**

- A. Anti-siphon vacuum breaker certified under ASSE 1011 and that is designed to be non-removable.
- B. Finish shall be either brass (Watts 8A) or chrome (Watts 8AC) to match the finish of the hose thread to which it is connecting.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install fixtures and make water supply, waste and vent connections as indicated on the drawings.
- B. Set fixtures in center of stalls, between partitions where required. Dimensions for spacing shall be verified with General Contractor. Fixtures in ADA accessible stalls shall be installed with the flush valve handle to the open side of the stall, where applicable.
- C. Setting shall be absolutely tight and rigid on proper ground. Use Miracle Adhesive Corporation Tub Caulk or approved equal pointing material under all setting surfaces.
- D. Wall hung fixtures shall be securely hung. All wall hung fixtures shall have carriers unless other mounting means are approved by Design Professional. Mounting heights shall be as indicated on Architectural elevations, and in accordance with the requirements of the ADA.
- E. Chair carriers shall be securely braced to construction and shall be concealed with feet concealed in floor. Where feet cannot be concealed in floor, provide stub feet. Carriers for urinals shall have thrust bolts at bottom. Carriers for lavatories and electric water coolers shall have mounting plate type hanger or concealed arms as required by the fixture schedule. Carriers shall be coordinated with plumbing fixtures.
- F. Fixtures shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the fixtures properly cleaned.
- G. Contractor shall be responsible for the protection of the fixtures until acceptance by Owner. Damaged fixtures shall be replaced at no additional cost to Owner.
- H. Joints of lavatories with counter and/or wall, sinks with wall, urinals with wall and water closets with wall and/or floor shall be caulked with transparent silicone caulk by Contractor.
- I. Provide a hose thread vacuum breaker at all locations indicated on the plans and at all threaded hose connections.

**END OF SECTION 22 40 00**

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## SECTION 22 46 00 - SECURITY PLUMBING FIXTURES.

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Combination units.
  - 2. Water closets.
  - 3. Flushometer valves.
  - 4. Urinals.
  - 5. Lavatories.
  - 6. Showers.
  - 7. Fixture supports for front-mounting, stainless-steel fixtures
  - 8. Electronic controls.
- B. Related Requirements:
  - 1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
  - 2. Division 22 Section "Plumbing Fixtures."

#### 1.3 DEFINITIONS

- A. Accessible Service Space: Service area in secure space behind wall-mounted fixtures.
- B. Accessible Fixture: Security plumbing fixture that can be approached and used by people with disabilities.
- C. Rear-Access Fixture: Security plumbing fixture designed to mount through wall, so installation and removal of fixture, piping, and other components are accessible only from service space behind wall.
- D. Front-Access Fixture: Security plumbing fixture designed to mount to wall with installation and removal from fixture side of wall, and with piping and other components accessible only from access panel(s) in fixture.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for security plumbing fixtures.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.

- D. Operation and Maintenance Data: For security plumbing fixtures to include in emergency, operation, and maintenance manuals.

## **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For security plumbing fixtures and components to include in maintenance manuals.

## **1.6 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with Americans with Disabilities Act requirements for security plumbing fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

## **1.7 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Flushometer-Valve Diaphragm Repair Kits
  - 2. Lavatory Valve Repair Kits.
  - 3. Shower Valve Repair Kits.

## **PART 2 - PRODUCTS**

### **2.1 COMBINATION UNITS**

- A. Security Combination Units
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Acorn Engineering Company.
    - b. Bradley Corporation.
    - c. Metcraft Industries Inc.
    - d. Willoughby Industries, Inc.
  - 2. Description: Back-mounting, cabinet, security plumbing fixture with integral water closet and lavatory; fabricated from 14 gauge thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
    - a. Water Closet: Comply with IAPMO PS 61 for water-closet component.
      - 1) Bowl: Elongated, with back inlet, integral trap, blowout jet design with back outlet and contoured seat.
        - a) Seat Surface: SSINA No. 7 polished finish.
        - b) Drain: Horizontal with cleanout and slip joint.

- 2) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button mechanism, and 1.6-gal./flush consumption. Refer to "Flushometer Valves" Article.
- b. Lavatory: In top of cabinet.
  - 1) Receptor: Oval or rectangular] bowl with integral soap depression.
  - 2) Hot- and Cold-Water Supply Valves: Electric-solenoid type with push-button actuation and individual check stop.
  - 3) Filler Spout: Backsplash or deck mounted.
  - 4) Drain: Integral punched grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2
  - 5) Toilet Paper Holder: Recessed, 0.063-inch minimum thickness, stainless steel complying with ASTM A 666, Type 304.
- c. Wall Sleeve: Galvanized-steel frame of dimensions required to match and support entire fixture. Include steel bars or other design that will prevent escape if fixture is removed.

## 2.2 LAVATORIES

### A. Security Lavatories

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company.
  - b. Bradley Corporation.
  - c. Metcraft Industries Inc.
  - d. Willoughby Industries, Inc.
- 2. Description: Back-mounting, security plumbing fixture; fabricated from 14 gauge, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
  - a. Receptor: Oval or rectangular bowl with integral soap depression and backsplash.
  - b. Hot- and Cold-Water Supply Valves: Pneumatic or Electric-solenoid type with push-button actuation and individual check stop.
  - c. Filler Spout: Backsplash or deck mounted.
  - d. Drain: Integral punched grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
  - e. Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.

### B. Security Lavatories

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company.
  - b. Bradley Corporation.
  - c. Metcraft Industries Inc.
  - d. Willoughby Industries, Inc.
- 2. Description: Front-mounting security plumbing fixture; fabricated from 14 thickness, ASTM A 666, Type 304, stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
  - a. Receptor: Oval or rectangular bowl with integral soap depression and backsplash.

- b. Hot- and Cold-Water Supply Valves: Pneumatic or Electric-solenoid type with push-button actuation and individual check stop.
- c. Filler Spout: Backsplash or deck mounted.
- d. Drain: Integral punched grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
- e. Access to Internal Components: Vandal-resistant access panels.
- f. Mounting Device: Wall bracket.
- g. Support: Chair carrier. Refer to "Fixture Supports" Article.

C. Security Showers

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company.
  - b. Bradley Corporation.
  - c. Metcraft Industries Inc.
  - d. Willoughby Industries, Inc.
- 2. Description: Front-mounting recessed security plumbing fixture made with wall plate for flush installation; fabricated from 14 gauge thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
  - a. Configuration: Wall type with shower head and soap dish.
  - b. Tempered Hot- and Cold-Water-Supply Valves: Pneumatic type with individual check stop.
  - c. Shower: Hose with vandal-resistant, hand-held head.
  - d. Soap Dish: Recessed, stainless steel.
  - e. Access to Internal Components: Vandal-resistant access panels.
  - f. Mounting Device: Wall-mounting frame.

D. Water Closets: In-floor, detox toilet.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company
  - b. Metcraft Industries, Inc.
  - c. Willoughby Industries.
- 2. Material: 14 gauge minimum-thickness, Type 304 stainless steel.
- 3. Finish: No. 4 satin finish on exposed surfaces, and matte finish on interior wetted surfaces.
- 4. Bowl:
  - a. Type: Blowout design, with back outlet, back inlet, and integral trap.
  - b. Receptacle: Rectangular, with 360-degree continuous flushing rim, and integral sloping rim.
  - c. Inlet Connection: 1-inch NPT male.
  - d. Back Outlet Waste Connection (Blowout): NPS 2, plain end.
  - e. Water Consumption: 1.6 gal. per flush.
- 5. Mounting: Floor flange.
- 6. Flushometer Valve: Mechanical type.

## 2.3 ELECTRONIC CONTROLS

### A. Electronic Controls: Electronic Networked Water Management System.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Willoughby Industries
  - b. Sloan Valve Company.
  - c. Acorn Engineering Company
2. Description:
  - a. Water Management System: PC-based server (operator workstation) running on Windows 8 or newer operating system. Network communications shall be CAN-bus based providing proactive, prioritized communications of status of controller inputs/activities to operator workstation. Polling-type networks shall not be permitted. PC shall serve as the operator interface serving single or multiple individual trunks of networked Cell Valve Controllers (CVC's). The PC operator workstation shall display all fixtures and indicate their operation and state graphically. PC shall be equipped with:
    - 1) Monitor: 19 inch or larger with HD resolution of 1366 by 768 pixels minimum.
    - 2) Touchscreen Monitor: Coordinate with owner.
    - 3) RAM: 4 GB minimum.
    - 4) Hard Drive: 64 GB minimum.
    - 5) Wireless keyboard.
    - 6) Wireless mouse.
    - 7) USB Ports: 4 minimum.
    - 8) CAN-bus interface device(s) for network communication to Cell Valve Controllers (CVC's).
    - 9) Water Management Software: Installed on PC, configured, and tested prior to installation to provide control and monitoring of security plumbing fixtures flush valves, lavatory valves, and shower valves connected to the CAN-bus networked control system.
  - b. WMS II operator workstation shall be located where indicated on the drawings.
  - c. Screen Graphics: Layout information (areas and cell numbers and fixtures controlled by networked system) shall be supplied to system supplier in DWG file format. Based on information supplied:
    - 1) Level 1 screen shall:
      - a) Display top-level layout of defined sections of the facility.
      - b) Provide selected areas identified by shape, color, and label to link Level 1 screen to Level 2 screens with enlarged details and fixtures of individual facility sections.
    - 2) Level 2 screens shall:
      - a) Provide magnified detail and fixture icons.
      - b) Provide identification of each fixture by location on the screen layout, icon type, and labeling (e.g., cell number of its location).
      - c) It shall be acceptable to use only a Level 1 screen if all fixtures can be displayed legibly and logically by functional area on one screen.

- d) Provide graphical indication of fixture status.
- d. Individual microprocessor-driven Cell Valve Controllers (CVCs) shall be located in the plumbing chase(s) and shall control the operation of electronic laboratory valves, electronic shower valves, electronic drinking fountain valves, and electronic-hydraulic flush valves. An option shall also be available to control the operation of master shut-off valve(s) that provide(s) water to an area of several cells or fixtures.
  - e. CVC's shall require 24 volts AC for operation. System manufacturer shall supply 120/24 VAC step-down transformers for each CVC supplied. Transformers shall be UL Class 2, overload protected.
  - f. Each CVC shall be capable of controlling up to 2 lavatory/toilet combination units (1 hot valve, 1 cold valve, and 1 flush valve for each combination unit), 3 individual lavatories, or up to 4 toilets with overflow sensing (6 toilets without overflow sensing), or combinations thereof up to a total of 6 individual low-voltage solenoid valves. CVC's shall be modular and capable of operating in a fully networked or stand-alone configuration.
  - g. Valve output LEDs on the CVC shall provide the status of all valve outputs. An additional set of status LEDs shall indicate the presence and type of any inhibit or lockout condition on valve function.
  - h. Diagnostic LEDs: Provided on CVC to indicate the presence of incoming AC control power, that the CVC is operational, communication status, and input status.
    - 1) HB LED (heartbeat): Flashes to show controller is not only powered, but that the program in the controller is running. It flashes on and off.
    - 2) COM LED: Indicating when there is network communications activity occurring.
    - 3) ERR LED: Indicating a communication error occurred.
    - 4) IN LED: Indicating one of the input switches is closed. (It can be used to diagnose input switch problems.)
  - i. Diagnostic pushbuttons on the CVC shall be provided to enable maintenance personnel to manually activate valves and overflow functions from the controller in the plumbing chase.
  - j. Valve activation shall come from vandal-resistant stainless steel internally sealed pushbuttons.
    - 1) Pushbuttons shall require less than 5 lbf to activate.
    - 2) Pushbutton housings shall be electrically isolated from system voltages.
  - k. All solenoid valves shall be non-hold open (normally closed), but all metering times shall be independently adjustable.
    - 1) Metering time shall be:
      - a) Adjustable from one (1) to sixty (60) seconds for each lavatory valve.
      - b) Adjustable from one (1) to ten (10) seconds for each flush valve.
    - 2) Metering cycles shall be interruptible with a second pushbutton.
    - 3) All settings shall be settable for a single fixture or a group selection of all fixtures of the same type on the PC screen.
  - l. Each controller shall be programmed at the factory to the following settings:
    - 1) Lavatory Valve Cycle: Fifteen (15) seconds hot water run time, fifteen (15) seconds cold water run time.
    - 2) Flush Valve Cycle (Water Closets and Urinals): Two (2) seconds on time.



- m. A programmable re-initiate delay feature function (toilets, urinals, lavatories) shall be provided to control their amount of use to a preset threshold, after which the function will be locked out for a preset period of time of up to four hours.
- n. A programmable initiate delay feature for the fixture function (toilets, urinals, lavatories) shall be provided to enable a timed delay between the pushbutton switch activation and the subsequent valve activation.
- o. System shall provide overuse control consisting of:
  - 1) Individual toilet, urinal, and lavatory use limits.
  - 2) Programmable response to overuse condition of notification at the operator workstation, latched lockout of fixture, or auto-limit of fixture operation to prevent its overuse. All overuse notifications shall appear on the operator workstation.
  - 3) Configurable overuse limitation to a given number (adjustable) of valve actuations for flushing devices or a given amount of cycle-on time (adjustable) for lavatories within a given time period (adjustable) of up to 24 hours.
  - 4) Concurrent operation with other use-control features of the system.
- p. The operator workstation shall be capable of networks of up to 508 CVC nodes and up to 3,048 valves.
- q. Network Wiring: Twisted 3-pair cable of CAT 3 rating shall be used for all network wiring (provided by others). Installer shall follow system manufacturer's instructions for installation and verification testing. Each network shall not exceed 4,000 feet in total length from operator workstation to the last CVC in the network string.
- r. In the event of a loss of network communications or loss of power, system timing parameters shall be retained in each CVC to allow fixtures to operate in the same way that they operated prior to the loss of power or the loss of network communications.
- s. Input/Output Ports Cabling:
  - 1) Each input/output shall be clearly identified by the use of harness location, color coding of wires, gender of connectors (1/4 inch fully insulated male tab connections for inputs and 1/4 inch fully insulated female tabs for outputs), and supplied documentation.
  - 2) All input/output cables shall be supplied with cables attached to the CVC and only outboard switch and valve connections to be plugged in by installer.
  - 3) Supplied valve and switch cabling from the CVC control board shall each be 8 feet with the option to add extensions if necessary.
- t. The networked system shall be capable of:
  - 1) Enabling or disabling an individual fixture or an entire group of fixtures from the operator workstation.
  - 2) Controlling the maximum number of simultaneous flushes (adjustable from 1 to 999) that can occur within a given time period (adjustable from 1 to 60 seconds).
  - 3) Automatically flushing a toilet or actuating a non-flushing fixture after an adjustable period of non-use has passed to prevent drying out or creating stagnate water.
  - 4) Allowing for remote actuation of fixtures from the operator workstation.
  - 5) Providing ability from the operator station to dynamically lock or reset (unlock) a fixture.
  - 6) Providing up to 4 scheduled permit time periods per day and week for selected fixtures.
  - 7) Providing indication and reset capability of overflow alarms.
  - 8) Logging of time, date, and function of all valve activity chronologically, including:
    - a) On and off times of each fixture function.
    - b) Lockout times.
    - c) Network status changes by node.

- u. The networked system shall provide 4 levels of security accessed via user name and password depending on system settings (Each level includes the functions of the previous lower level).
  - 1) View-only Security Level:
    - a) Move between display screens.
    - b) Observe fixture activity on screens.
    - c) Observe any loss of communications to fixture controllers.
    - d) Log into a higher-security level.
  - 2) Operator Security Level:
    - a) Remote valve actuation.
    - b) Fixture lockout/reset.
    - c) Clear alarms (overflow and overuse).
  - 3) Supervisor Security Level:
    - a) Set and adjust valve timing.
    - b) Set and adjust initiate and re-initiate delays.
    - c) Set and adjust permit (lockout) schedules.
    - d) Set and adjust overuse limits and responses.
    - e) Set alarm display options.
    - f) Enable/disable and set FlushGuard to limit simultaneous flushes.
    - g) Access fixture event log (if enabled by administrator).
    - h) Use log files to analyze water-consumption history.
    - i) Enable and disable sound effects.
    - j) Access system user activity log files (if enabled by administrator).
    - k) Optional selection of a 24-hour point at which all overuse counts will be reset.
  - 4) Administrator Security Level:
    - a) Create system user accounts with user name, password, and security level defined.
    - b) Set and adjust network communications settings.
    - c) Enable and configure remote client connections to server.
    - d) Configure fixture event log files and user activity log files.
    - e) Set sound files to be used when sound feature is enabled.
- v. Client-server Networking System shall be capable of linking client sessions on other Windows-based PCs to the main server via an Ethernet network. Control and monitor functions possible on the central operator station may be performed on a client PC based on user security level.
  - 1) Server will be located where indicated on drawings.
  - 2) Water management software shall be installed, configured, and verified by system integrator with assistance from water management software supplier.
- w. Solenoids compatible with voltage, power, and mating connections of the outputs of the CVC.
- x. Supply shut off valve: One valve for each water supply.
- y. Controller (CVC) Housing: Water resistant enclosure.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install security plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install back-access, stainless-steel fixtures as follows:
  - 1. Install wall sleeve in wall if indicated.
  - 2. Install fixture on wall sleeve or wall, as indicated, with access from accessible service space.
  - 3. Extend supply piping from service space to fixture.
  - 4. Install soil and waste piping from fixture and extend into service space.
  - 5. Install fixture trap in service space instead of below fixture drain.
- C. Install front-access, stainless-steel fixtures as follows:
  - 1. Install fixture support or mounting bracket.
  - 2. Install fixture on support; mount components inside of or attached to fixture.
  - 3. Extend supply piping from pipe space to fixture.
  - 4. Install trap below fixture and extend soil and waste piping into pipe space.
- D. Install fixture outlets with gasket seals.
- E. Install fixtures designated "accessible" according to ICC A117.1 for heights, dimensions, and clearances.
- F. Install toilet seats on combination units if seats are indicated.
- G. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible fixtures. Comply with requirements in Section 22 07 00 "Plumbing Insulation."
- H. Seal joints between fixtures, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- I. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 00 "Common Work Results for Plumbing."
- J. If networked electronic controls are utilized, network wiring "provided by others" shall be installed and tested per the plumbing control system supplier's instructions.

### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

- B. Comply with requirements for water piping specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with requirements for soil and waste drainage piping specified in Section 221316 "Sanitary Waste and Vent Piping."

**3.4 ADJUSTING**

- A. Operate and adjust flushometer valves and flow-control valves on fixtures.

**3.5 CLEANING AND PROTECTION**

- A. After installing fixtures, inspect and repair damaged finishes.
- B. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 46 00**

## SECTION 22 47 00 - DRINKING FOUNTAINS AND WATER COOLERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 22 00 10 - Plumbing General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary for the plumbing fixture installation as required by the drawings and this section.
- B. Fixtures, trim and accessories shall be of type and model numbers as scheduled on the drawings.

#### 1.3 QUALITY ASSURANCE

- A. ANSI/NSF 372 Certification: Drinking Fountains and Water Coolers shall meet the requirements of ANSI/NSF 372 Certification, Drinking Water System Components, Lead Content.

#### 1.4 SUBMITTALS

- A. Submit catalog cuts giving manufacturer's model numbers, fixture and rough in dimensions, and construction material for each type of fixture, trim and accessory scheduled.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Electric Water Coolers
  - 1. Elkay
  - 2. Halsey Taylor
  - 3. Haws
  - 4. Oasis
  - 5. Sunroc/Western

#### 2.2 ELECTRIC WATER COOLERS

- A. Refer to Plumbing Fixture Schedule for models and accessories.
- B. Provide with factory wired 3-prong power cord(s) for unit power.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install fixtures and make water supply, waste and vent connections as indicated on the drawings.
- B. Fixtures shall be covered after they are set to prevent damage during the balance of construction. At the conclusion of work, the covering shall be removed and the fixtures properly cleaned.

- C. Contractor shall be responsible for the protection of the fixtures until acceptance by Owner. Damaged fixtures shall be replaced at no additional cost to Owner.

**END OF SECTION 22 47 00**

**DIVISION 23**





## SECTION 23 00 10 - HVAC GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements, which all apply to work under this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section applies to all work under the HVAC contract. This shall include, but not necessarily be limited to, the following:
  - 1. Piping Insulation
  - 2. Ductwork for Air Distribution
  - 3. Grilles, Registers, Diffusers and Dampers
  - 4. Exhaust Fans and Ducts
  - 5. Thermostats and Control Wiring
  - 6. Insulation of Ducts and Plenums
  - 7. Furnaces and Condensing Units and Refrigerant Piping
  - 8. Unit Air Conditioners
  - 9. Hot Water Boiler
  - 10. Water Chillers
  - 11. Terminal Heating and Cooling Units
  - 12. Hydronic Piping
- B. The work shall include all materials, equipment and labor required for complete and properly functioning HVAC systems.
- C. Drawings for HVAC work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, piping and approximate sizes and locations of equipment and materials.
- D. Where job conditions require reasonable changes in indicated locations and arrangements, make such changes without additional cost to Owner.
- E. Because of the scale of the drawings, certain piping or items such as unions or fittings may not be shown, but where such items are required by other sections of the specifications, or where they are required by the nature of the work, they shall be furnished and installed.
- F. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- G. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

#### 1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
  - 1. International Fire Suppression Code
  - 2. Uniform Fire Suppression Code

3. International Plumbing Code
  4. Uniform Plumbing Code
  5. Wisconsin State Plumbing Code
  6. International Plumbing Code
  7. Uniform Building Code
  8. National Electric Code (NEC)
  9. National Fire Protection Association Standards (NFPA)
  10. Local Utility Company Requirements
  11. Local Codes, all trades
  12. Standards of ASME, ASHRAE, NEMA, IEEE, AGA, SMACNA
  13. Occupational Safety and Health Administration (OSHA)
  14. Underwriters Laboratories, Inc. (U.L.)
  15. Wisconsin Administrative Codes
  16. Americans With Disabilities Act (ADA)
- B. Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.
- C. Where drawings or specifications call for workmanship or materials in excess of code requirements, a lower grade of construction will not be permitted.

#### **1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES**

- A. Secure all required permits and pay for all inspections, licenses and fees required in connection with the HVAC work. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

#### **1.5 HVAC DRAWINGS**

- A. The HVAC drawings indicate in general the building arrangement only, Contractor shall examine construction drawings to familiarize himself with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.
- B. Drawings are intended to convey the scope of the work and to indicate the general arrangement and locations of ducts, piping and equipment.
- C. Contractor shall layout his own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of piping and ducts so as to best fit the layout of the work.
- D. Contractor shall take his own field measurements for verifying locations and dimensions: scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as pipe fittings and valves may not be shown, but where such items are required by code or by other sections of the specifications, such items shall be furnished and installed.

#### **1.6 ACTIVE SERVICES**

- A. Contractor shall be responsible for verifying exact location of all existing services prior to beginning work in that area.

- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

#### **1.7 SITE INSPECTION**

- A. Contractor shall inspect the site prior to submitting bid for work to familiarize himself with the conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

#### **1.8 COORDINATION AND COOPERATION**

- A. It shall be Contractor's responsibility to schedule and coordinate his work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of his work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment and the building. Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and his decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting and plaster until the project is substantially completed. Damage from rust, paint and scratches shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in finished areas of the building, Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.

## **1.9 OPENINGS, CUTTING AND PATCHING**

- A. Piping, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, sleeve, and/or duct shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where piping, sleeves and ducts pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk. Refer to Section 07 8400 – Firestopping and Section 07 9200 – Joint Sealants for additional information.
  
- B. New structure:
  - 1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the HVAC work with the General Contractor.
  - 2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.
  
- C. Existing Structure:
  - 1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of his work, and shall furnish lintels and supports as required for openings.
  - 2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
  - 3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.

## **1.10 EXCAVATING AND BACKFILLING**

- A. Contractor shall do all excavating necessary for hydronic piping, gas piping, etc., and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the pipe. Excavation shall be kept free from water by pumping if necessary.
  
- B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit. Backfill shall be in accordance with Division 31 Specifications.
  
- C. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit and shall be carried to a crown approximately six (6) inches above existing grades. In backfilling trenches, selected material shall be compacted firmly around and to a depth of not less than six (6) inches over the top of work in trench. All fill and backfill and rough grading shall be compacted thoroughly in layers and shall be brought up to within six (6) inches of finished grades. All fill and backfill shall be sand or pit run sand/gravel graded from 1" size downward, if excavated material is not suitable for backfill.

**1.11 MATERIALS AND EQUIPMENT**

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item. Where two or more units are required of the same item, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items, when required, shall be furnished as part of the equipment, whether or not specifically called for.

**1.12 SUBMITTALS**

- A. Contractor shall furnish, to Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements. Refer to Section 01 3000 - Administrative Requirements for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, Contractor shall provide a completed submittal schedule including dates that the submittals will be to Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 05 16	Expansion Fittings and Loops for HVAC Piping		X					
23 05 19	Meters and Gauges for HVAC Piping		X					
23 05 23	General Duty Valves for HVAC Piping		X					
23 05 48	Vibration Controls for HVAC Piping, Ductwork and Equipment		X					
23 05 53	HVAC Identification		X					
23 05 93	Testing, Adjusting and Balancing for HVAC							1
23 07 00	HVAC Insulation		X					
23 09 00	Building Automation System	X	X			X	X	

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 11 13	Facility Fuel-Oil Piping		X					
23 21 13	Hydronic Piping:							
	Expansion Tanks		X			X		
	Air Separator		X			X		
	Auto Flow Ctrl ValvePress &Temp Test StationAir Vents Sys Fill Press Valve		XXXX			XX		
	Venturi Flow MeasureAuto Flow Ctrl ValvePress &Temp Test StationAir Vents		XXXX			XX		
	Chem. Treat. FeederVenturi Flow MeasureAuto Flow Ctrl ValvePress &Temp Test Station		XXXX			XX		
	Cool Tower Chem TreatChem. Treat. FeederVenturi Flow MeasureAuto Flow Ctrl Valve		XXXX			XXX		
	Triple Duty ValveCool Tower Chem TreatChem. Treat. FeederVenturi Flow Measure		XXXX			XXXX		
	Backflow PreventersTriple Duty ValveCool Tower Chem TreatChem. Treat. Feeder		XXXX			XXXX		
23 31 1323 22 2323 21 2323 21 13.33	Metal DuctsSteam & Cond. PumpsHydronic PumpsGround Heat Exchanger Test Boring	XX	XXXX			XX	X	12
23 31 1623 31 1323 22 2323 21 23	Non-Metal DuctsMetal DuctsSteam & Cond. PumpsHydronic Pumps	XX	XXXX			XX	X	1
23 33 0023 31 1623 31 1323 22 23	Air Duct AccessoriesNon-Metal DuctsMetal DuctsSteam & Cond. Pumps	XX	XXXX			XX		1
23 34 1623 33 0023 31 1623 31 13	HVAC FansAir Duct AccessoriesNon-Metal DuctsMetal Ducts	XX	XXXX			XX	X	1
23 34 3323 34 1623 33 0023 31 16	Air CurtainsHVAC FansAir Duct AccessoriesNon-Metal Ducts	X	XXXX			XXX	X	
23 36 0023 34 3323 34 1623 33 00	Air Terminal UnitsAir CurtainsHVAC FansAir Duct Accessories		XXXX			XXXX	X	
23 37 1323 36 0023 34 3323 34 16	Diffusers, Registers and GrillesAir Terminal UnitsAir CurtainsHVAC Fans		XXXX			XXX	X	

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 37 2323 37 1323 36 0023 34 33	HVAC Gravity VentilatorsDiffusers, Registers and GrillesAir Terminal UnitsAir Curtains		XXXX			XX		
23 38 1323 37 2323 37 1323 36 00	Commercial Kitchen Exhaust EquipmentHVAC Gravity VentilatorsDiffusers, Registers and GrillesAir Terminal Units		XXXX			XX		
23 41 0023 38 1323 37 2323 37 13	Particulate Air FiltrationCommercial Kitchen Exhaust EquipmentHVAC Gravity VentilatorsDiffusers, Registers and Grilles		XXXX			X		
23 51 0023 41 0023 38 1323 37 23	Breeching, Chimneys & StacksParticulate Air FiltrationCommercial Kitchen Exhaust EquipmentHVAC Gravity Ventilators		XXXX			X		
23 52 1623 51 0023 41 0023 38 13	Condensing BoilersBreeching, Chimneys & StacksParticulate Air FiltrationCommercial Kitchen Exhaust Equipment		XXXX			XX	X	
23 52 2323 52 1623 51 0023 41 00	Cast Iron BoilersCondensing BoilersBreeching, Chimneys & StacksParticulate Air Filtration		XXXX			XX	XX	
23 52 3323 52 2323 52 1623 51 00	Water Tube BoilersCast Iron BoilersCondensing BoilersBreeching, Chimneys & Stacks		XXXX			XXX	XXX	
23 52 3923 52 3323 52 2323 52 16	Fire Tube BoilersWater Tube BoilersCast Iron BoilersCondensing Boilers		XXXX			XXXX	XXXX	
23 53 1323 52 3923 52 3323 52 23	Boiler Feed Water PumpsFire Tube BoilersWater Tube BoilersCast Iron Boilers		XXXX			XXXX	XXXX	
23 54 0023 53 1323 52 3923 52 33	FurnacesBoiler Feed Water PumpsFire Tube BoilersWater Tube Boilers		XXXX			XXXX	XXX	
23 55 1323 54 0023 53 1323 52 39	Fuel Fired Duct HeatersFurnacesBoiler Feed Water PumpsFire Tube Boilers		XXXX			XXXX	XX	
23 55 2323 55 1323 54 0023 53 13	Gas Fired Radiant HeatersFuel Fired Duct HeatersFurnacesBoiler Feed Water Pumps		XXXX			XXXX	X	
23 55 3323 55 2323 55 1323 54 00	Fuel Fired Unit Heaters Gas Fired Radiant HeatersFuel Fired Duct HeatersFurnaces		XXXX			XXXX		

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 57 0023 55 3323 55 2323 55 13	Heat Exchangers for HVACFuel Fired Unit Heaters Gas Fired Radiant HeatersFuel Fired Duct Heaters		XXXX			XXXX		
23 62 0023 57 0023 55 3323 55 23	Packaged Compressor and Condenser UnitsHeat Exchangers for HVACFuel Fired Unit Heaters Gas Fired Radiant Heaters		XXXX			XXXX		
23 64 1623 62 0023 57 0023 55 33	Centrifugal Water ChillersPackaged Compressor and Condenser UnitsHeat Exchangers for HVACFuel Fired Unit Heaters		XXXX			XXXX	X	
23 64 1923 64 1623 62 0023 57 00	Reciprocating Water ChillersCentrifugal Water ChillersPackaged Compressor and Condenser UnitsHeat Exchangers for HVAC		XXXX			XXXX	XX	
23 64 2323 64 1923 64 1623 62 00	Scroll Water ChillersReciprocating Water ChillersCentrifugal Water ChillersPackaged Compressor and Condenser Units		XXXX			XXXX	XXX	
23 64 2623 64 2323 64 1923 64 16	Rotary Screw Water ChillersScroll Water ChillersReciprocating Water ChillersCentrifugal Water Chillers		XXXX			XXXX	XXXX	
23 65 0023 64 2623 64 2323 64 19	Cooling TowersRotary Screw Water ChillersScroll Water ChillersReciprocating Water Chillers		XXXX			XXXX	XXXX	
23 72 0023 65 0023 64 2623 64 23	Air-to-Air Energy Recovery EquipmentCooling TowersRotary Screw Water ChillersScroll Water Chillers		XXXX			XXXX	XXXX	
23 73 1323 72 0023 65 0023 64 26	Modular Indoor Central Station Air-Handling UnitsAir-to-Air Energy Recovery EquipmentCooling TowersRotary Screw Water Chillers		XXXX			XXXX	XXXX	
23 73 2323 73 1323 72 0023 65 00	Custom Indoor Central-Station Air-Handling UnitsModular Indoor Central Station Air-Handling UnitsAir-to-Air Energy Recovery EquipmentCooling Towers		XXXX			XXXX	XXXX	



SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 74 1323 73 2323 73 1323 72 00	Packaged Outdoor Central Station Air Handling Units Custom Indoor Central-Station Air-Handling Units Modular Indoor Central Station Air-Handling Units Air-to-Air Energy Recovery Equipment		XXXX			XXXX	XXX	
23 74 3323 74 1323 73 2323 73 13	Packaged Outdoor Heating & Cooling Make-Up Air-Conditioners Packaged Outdoor Central Station Air Handling Units Custom Indoor Central-Station Air-Handling Units Modular Indoor Central Station Air-Handling Units		XXXX			XXXX	XX	
23 81 1923 74 3323 74 1323 73 23	Self-Contained Air Conditioners Packaged Outdoor Heating & Cooling Make-Up Air-Conditioners Packaged Outdoor Central Station Air Handling Units Custom Indoor Central-Station Air-Handling Units		XXXX			XXXX	X	
23 81 2623 81 1923 74 3323 74 13	Split System Air Conditioners Self-Contained Air Conditioners Packaged Outdoor Heating & Cooling Make-Up Air-Conditioners Packaged Outdoor Central Station Air Handling Units		XXXX			XXXX		
23 81 4623 81 2623 81 1923 74 33	Water Source Unitary Heat Pumps Split System Air Conditioners Self-Contained Air Conditioners Packaged Outdoor Heating & Cooling Make-Up Air-Conditioners		XXXX			XXXX		
23 82 1623 81 4623 81 2623 81 19	Air Coils Water Source Unitary Heat Pumps Split System Air Conditioners Self-Contained Air Conditioners		XXXX			XXX		
23 82 1923 82 1623 81 4623 81 26	Fan Coil Units Air Coils Water Source Unitary Heat Pumps Split System Air Conditioners		XXXX			XXX		
23 82 2323 82 1923 82 1623 81 46	Unit Ventilators Fan Coil Units Air Coils Water Source Unitary Heat Pumps		XXXX			XXX		
23 82 3323 82 2323 82 1923 82 16	Convectors and Radiant Heaters Unit Ventilators Fan Coil Units Air Coils		XXXX			XX		

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
23 82 3923 82 3323 82 2323 82 19	Unit Heaters Convectors and Radiant Heaters Unit VentilatorsFan Coil Units		XXXX			XXX		
23 84 1323 82 3923 82 3323 82 23	HumidifiersUnit Heaters Convectors and Radiant Heaters Unit Ventilators		XXXX			XXX	X	
NOTES: 1. Submit test reports as described in specification section. 2. Submit borehole log and record drawings.23 84 1323 82 3923 82 33	HumidifiersUnit Heaters Convectors and Radiant Heaters		XXX			XX	X	
NOTES: 1. Submit test reports as described in specification section. 2. Submit borehole log and record drawings.23 84 1323 82 39	HumidifiersUnit Heaters		XX			XX	X	
NOTES: 1. Submit test reports as described in specification section. 2. Submit borehole log and record drawings.23 84 13	Humidifiers		X			X	X	

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF DEMONSTRATION	OTHER (SEE NOTES)
NOTES: 1. Submit test reports as described in specification section.  2. Submit borehole log and record drawings.								

- F. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- G. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.

**1.13 OPERATION AND MAINTENANCE MANUALS**

- A. Operation and maintenance manuals shall be submitted to Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION  
 AND  
 MAINTENANCE  
 MANUAL  
 FOR  
 HVAC SYSTEMS

(PROJECT NAME)  
 (LOCATION)  
 (DATE)

SUBMITTED BY  
 (NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
  - 1. Equipment and system warranties and guarantees.
  - 2. Installation instructions.
  - 3. Operating instructions.

4. Maintenance instructions.
5. Spare parts identification and ordering list.
6. Local service organization, address, contract and phone number.
7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
8. Reports of all tests and demonstrations including certificate of owner instruction, testing and balancing report, etc.

**1.14 TESTS AND DEMONSTRATIONS**

- A. Tests Required: Piping shall be tested and proved tight under the following static pressures. Pressure shall be maintained for four (4) hours.

<u>System</u>	<u>Pressure</u>
Hydronic Piping	150 psi (water)
Steam Piping	150 psi (water)
Oil Piping	150 psi air pressure.
Refrigeration Piping: Precharged Lines	Charge and operate unit. Check for leaks with electronic leak detector.
Fuel Piping	100 psi air pressure or 150% of operating pressure (whichever is greater)

- B. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Contractor shall submit a report to Design Professional citing dates, times, pressures, and results of all tests performed.

**1.15 TRAINING AND DEMONSTRATIONS**

- A. Prior to acceptance of the HVAC installation, Contractor shall provide to Owner, or his designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.

1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
2. Prepare the instruction format for a minimum of four Owner Representatives.

- B. Equipment training for Owner:

1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
3. Training shall be performed by qualified factory trained technicians.
4. HVAC Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

C. System training for Owner:

1. HVAC and Temperature Controls Contractors shall jointly conduct system operating training. These sessions shall include:
  - a. HVAC system overview.
  - b. System wide start-up.
  - c. Operation of control system.
  - d. Function of each component.
  - e. System operating procedures in all possible modes.
  - f. Programming procedures.
  - g. Shut-down and maintenance procedures.
  - h. Emergency procedures.

D. The following are minimum requirements for Owner instruction:

Section	Description	Hours (Note 1)	Presented By	Others Present	Remarks
23 00 10	HVAC System (Excluding Equipment)	8	Mech. Contractor T.C. Contractor		Note 2
23 21 13	Hydronic Piping - Water Treatment	4	Manufacturer's Representative	Contractor	
23 21 23	Hydronic Pumps	4	Contractor		
23 5X XX	Central Heating Equip.	4	Manufacturer's Representative	Contractor	
23 64 XX	Chillers	16	Manufacturer's Representative	Contractor	Note 3
23 65 00	Cooling Towers	4	Manufacturer's Representative	Contractor	
23 7X XX	Central HVAC Equip.	4	Contractor		
23 34 16	Fans	2	Contractor		
23 84 13	Humidifiers	4	Manufacturer's Representative	Contractor	
23 09 00	Temperature Control System	40	T.C. Contractor		Note 3
<ol style="list-style-type: none"> <li>1. Any unused hours shall be used at Owner's discretion during the first year of occupancy.</li> <li>2. System training shall include, but not be limited to, valve locations, system routing, and air/water flow patterns, system start-up/shut-down/emergency procedures.</li> <li>3. Training shall occur in several sessions over the course of the first year of operation. A minimum of four separate dates are required for temperature controls, two dates for chillers.</li> </ol>					

- E. Contractor shall submit to Design Professional a certificate, signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner's satisfaction. An example of a certificate form is as follows:

**CERTIFICATE OF SYSTEM DEMONSTRATION**

This document is to certify that Contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: \_\_\_\_\_

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: \_\_\_\_\_

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

\_\_\_\_\_ signature

\_\_\_\_\_ date

Owner's Representative:

\_\_\_\_\_ signature

\_\_\_\_\_ date

## **1.16 SUBSTITUTIONS**

- A. Refer to Divisions 00 and 01. Refer to Section 01 25 00 – Substitution Procedures.
- B. To obtain approval to use unspecified equipment, submit written requests to the Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- C. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

## **1.17 ACCEPTABLE MANUFACTURERS**

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be his responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions (including accessibility for maintenance), operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

## **1.18 WARRANTY**

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
  - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
    - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.

- b. The entire HVAC system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 23 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

**1.19 CHANGES IN THE WORK**

- A. A contract change order is a written order to Contractor signed by Owner and Contractor, issued after the execution of the contract, authorizing a change in the work or an adjustment in the contract sum or the contract time. The contract sum and the contract time may be changed only by contract change order.
- B. Owner, without invalidating the contract, may order changes in the work within the general scope of the contract consisting of additions, deletions or other revisions, with the contract sum and the contract time being adjusted accordingly. All such changes in the work shall be authorized by contract change order and shall be performed under the applicable conditions of the contract documents.
- C. The cost or credit to Owner resulting from a change in the work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. A change order in excess of \$300.00 shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.
- D. It shall be the responsibility of Contractor before proceeding with any change to satisfy himself that the change has been properly authorized in behalf of Owner.

**1.20 COMPLETION**

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

**1.21 CLEANING**

- A. Prior to assembly of pipe and piping components, all loose dirt, scale, oil, and other foreign matter on internal and exterior surfaces shall be removed by means consistent with good piping practices. During fabrication and assembly, slug and weld splatter shall be removed from both internal and external pipe joints by preening, chipping, and wire brushing.



- B. At the conclusion of the construction, the entire system of piping and equipment shall be cleaned internally. Prior to flushing erected piping surfaces, Contractor shall disconnect all instrumentation and equipment and open wide all valves.
- C. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- D. Heating and air conditioning equipment shall be thoroughly cleaned and clean filters installed.

## **1.22 ELECTRICAL WORK**

- A. Electrical work and equipment provided by HVAC Contractor shall include the following:
  - 1. Starters and disconnects for motors of HVAC equipment, but only where specifically indicated to be furnished integrally with equipment.
  - 2. Wiring from motors to disconnect switches or junction boxes for motors of HVAC equipment, but only where specifically indicated to be furnished integrally with equipment.
  - 3. Electrical heating coils and similar elements in HVAC equipment.
  - 4. All control wiring in accordance with the requirements of Division 26.
- B. Electrical Contractor shall provide all power wiring for HVAC equipment, including services for motors and equipment furnished by the HVAC contractor. Motor and equipment locations are shown on the electrical drawings.
- C. Electrical Contractor shall make final connections for all motors and equipment furnished by the HVAC contractor.
- D. Electrical Contractor shall furnish safety disconnects and starters for all motors and equipment furnished by the HVAC contractor (unless specifically indicated to be furnished integrally with the equipment), so as to make service complete to each item of equipment.
- E. Contractor shall consult with Electrical Contractor prior to conduit rough-in and shall verify with him the exact locations for rough-ins, and the exact size and characteristics of the services required, and shall provide Electrical Contractor a schedule of electrical loads for the equipment furnished by him. These schedules will be used for sizing services, disconnects, fuses, starters and overload protection.
- F. Refer to Division 23 Controls section for control system wiring. Control wiring shall be done in accordance with the requirements of Division 26.
- G. All conduit installed for control wiring shall be blue. Labeled conduit will not be accepted.
- H. Control wiring, where not exposed, may be installed without conduit. Wiring in ducts, plenums and other air handling spaces shall be specifically listed for the use. All exposed control wiring and wiring behind inaccessible construction (such as in walls and above drywall ceilings) shall be routed in blue conduit. All wall penetrations shall be sleeved with blue conduit. Installation shall comply with all code requirements.
- I. All control wiring shall be in blue conduit.

## **1.23 TEMPORARY UTILITIES**

- A. Refer to Division 01 for specific requirements concerning temporary utilities.

- B. Under no circumstances shall the building HVAC equipment be used for temporary heat, cooling or ventilation during construction prior to Owner acceptance of the building at substantial completion.

**END OF SECTION 23 00 10**

## SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 0010 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section includes the following:
  - 1. Demolition
  - 2. Sleeves
  - 3. Escutcheons
  - 4. Fire Stopping
  - 5. Guards
  - 6. Wall Access Doors
  - 7. Equipment Pads

### PART 2 - PRODUCTS

#### 2.1 DEMOLITION MATERIALS

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site by him, unless otherwise specified.

#### 2.2 SLEEVES

- A. Sleeves passing through non load bearing walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:
  - 1. For pipes 2 1/2" and smaller 24 gauge
  - 2. For pipes 3" to 6" 22 gauge
  - 3. For pipes over 6" 20 gauge
- B. Sleeves passing through load bearing walls, concrete beams, fireproof walls, foundations, footings and waterproof floors shall be Schedule 40 steel pipe or cast iron pipe.
- C. Sleeves are not required in masonry walls which are core drilled or walls of drywall construction, except where partition is a firestop, smokestop, or side of air plenum.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- E. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water and fill space between sleeves and pipe with graphite packing and caulking compound.

- F. Sleeves passing through membrane waterproofing or lead safe shall be provided with flashing, furnished and installed by General Contractor, extending 12" beyond sleeve in all directions; flashing shall be secured and sealed to membrane or lead safe and shall be sealed to sleeve and caulked watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 6" above roof.
- G. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and pipe shall be sealed with modular rubber links tightened with bolts (Link-Seal or equal). Waterproofing of pipe penetrations in exterior walls shall be coordinated with waterproofing contractor.

### **2.3 ESCUTCHEONS**

- A. Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve but not to insulation with set screws or other approved devices.

### **2.4 FIRESTOPPING**

- A. Piping, conduit, sleeves and ducts passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and pipe, conduit, sleeve, and/or duct shall be sealed with UL Listed intumescent fire barrier material equivalent to rating of wall/floor. Refer to Section 07 8400 – Firestopping for additional information.

### **2.5 DETENTION WALL AND FLOOR BARRIER GRILLES**

#### **2.6 For all ductwork with a diameter greater than 6-inches penetrating a Detention wall and floor structure, a barrier grille constructed with a minimum of 3/4" diameter steel bars with a maximum bar spacing of 6-inches. Barrier grilles to be installed to effectively maintain security between secure and non-secure areas. DETENTION AREA ROOM TEMPERATURE SENSOR**

- A. Wall mounted room thermostats are not allowed within the Detention area. Room temperature sensor to be located in the exhaust duct or return duct serving the room. Located temperature sensor as close to exhaust/return grille as possible that prevents tampering through security grille, but can be accessed for maintenance when security grille is removed.

### **2.7 WALL ACCESS DOORS**

- A. When HVAC Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, HVAC Contractor shall provide a flush access door. The access door shall be equal to a Karp DSC-214M Universal access door for non-rated construction or KRP-150FR for fire rated construction. Other approved manufacturers include Nystrom, Acudor, and Access Panel Solutions, with model applicable to the specific construction involved.
- B. Access doors in fire rated construction shall be fire rated and have U.L. label. Refer to Architectural/General Construction plans for fire ratings.
- C. Construction
  1. Door and trim shall be 13 gauge steel, frames shall be 16 gauge steel.
  2. Trim shall be of one piece construction.

3. Finish shall be prime coat of rust inhibitive baked grey enamel.
4. Hinges shall be concealed, offset, floating hinge.
5. Locks shall be flush, screwdriver operated with stainless steel cam-and-studs.

## **PART 3 - EXECUTION**

### **3.1 DEMOLITION**

#### **A. General:**

1. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.
2. Contractor shall remove existing equipment and piping not necessary for additions or existing portions of building as indicated on drawings and/or specified herein. To include all abandoned equipment and piping back to point of origin. Demolition of equipment shall include removal associated concrete equipment pad and/or support steel.
3. Contractor shall be responsible for the cutting and capping of all existing services before any work is commenced by the General Contractor.

#### **B. Work by Others:** Unless specifically noted under other contracts, Contractor shall assume all required work shall be performed by him. In general, the following will be performed by others:

1. General Contractor will remove any floors, walls and ceilings, neatly patch, match, complete and finish all affected surfaces.
2. Electrical Contractor will disconnect all electrical services and remove abandoned conduit back to point of origin.

#### **C. Existing Conditions:**

1. If any piping serving existing fixtures or equipment which are to remain are disturbed by operations under this Contract, Contractor shall provide pipe and insulation required to reestablish continuity of such piping systems.
2. Contractor shall arrange for General Contractor to repair, patch and paint all construction, with material necessary to match surrounding material, which is necessary due to removal of equipment and piping.
3. Contractor shall furnish all required labor and material where required to extend new work to connect to similar work where new addition adjoins existing building and for extension of existing system. Connection shall be made in a suitable manner.

#### **D. Owner's Right of Salvage:** The Owner may designate and have salvage rights to any material herein demolished by the Contractor.

### **3.2 SLEEVES**

- #### **A.** Install sleeves for all piping passing through floors, roof, walls, concrete beams and foundations as required by this section.

### **3.3 ESCUTCHEONS**

- #### **A.** Install escutcheons for all pipes entering finished spaces.

### **3.4 GUARDS**

- A. Where exposed insulated piping extends to floor, provide sheet metal guard around insulation to extend up from floor 48". Guard to be galvanized sheet not less than 26 gauge.

### **3.5 ACCESS DOORS**

- A. Install access doors per manufacturer's recommendations.

### **3.6 CONCRETE EQUIPMENT PADS**

- A. Provide equipment housekeeping pads for all floor mounted equipment unless noted otherwise. Anchor equipment to concrete equipment pads according to equipment manufacturer's recommendations.
  - 1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in both directions than supported unit. Pads to be a minimum of 4" in height unless noted otherwise.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts according to manufacturer's recommendations and to elevations required for proper attachment to supported equipment.
  - 6. Use 3000-psi compressive strength concrete with #3 rebar 12" O.C.

### **3.7 ROOF MOUNTED EQUIPMENT CURBS**

- A. Mechanical Contractor to provide equipment curbs for all roof mounted mechanical equipment. Mechanical Contractor to coordinate insulation, flashing and water stopping of equipment curbs with Roofing Contractor to allow a water-tight construction.

**END OF SECTION 23 05 00**

## SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### 1.3 SUBMITTALS

- A. Submit for all motors provided.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Comply with NEMA MG1 unless noted otherwise.
- B. Constant Speed Motors: Minimum 1.15 service factor; rated at 40 deg. C. ambient temperature with 90 deg. C. temperature rise (Class B insulation).
- C. Motors Used with Variable Frequency Controllers: Inverter duty rated, Class F insulation (minimum). Windings shall be copper magnet with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters. Shall include Aegis motor shaft grounding rings.
- D. Multiple speed motors: Multiple windings.
- E. Motor Efficiency: Premium efficiency as defined in NEMA MG1.
- F. All motors shall be provided as required for motor orientation within equipment.
- G. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulations.

- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torques.
- I. Motor Enclosures:
  - 1. Shall be the NEMA types shown on the drawings for the motors.
  - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types which are most suitable for the environmental conditions where the motors are being installed. Motors located outdoors to be totally enclosed weatherproof epoxy-sealed type.
  - 3. Thoroughly clean and paint the enclosures at the factory with manufacturer's prime coat and standard finish.
- J. Additional requirements for specific motors, as indicated in other sections, shall also apply.

## **2.2 SINGLE PHASE POWER**

- A. Capacitor start motors starting torque shall be three times full load torque and starting current shall be less than five times full load current.
- B. Pull-up Torque: Up to 350 percent of full load torque.
- C. Breakdown Torque: Approximately 250 percent of full load torque.
- D. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- E. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- F. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

## **2.3 THREE PHASE POWER - SQUIRREL CAGE MOTORS**

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.



- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

## **2.4 ELECTRONICALLY COMMUTATED MOTORS**

- A. Where indicated, provide electronically commutated motors with the following features:
  1. Brushless, permanent magnet DC motor
  2. Built in inverter
  3. Microprocessor based controller for speed control.
  4. 0-10VDC or 0-20mA input signal
  5. Minimum 70% efficiency through all speeds.
  6. Bearings rated for L10 40,000 hours of continuous operation

### **PART 3 - EXECUTION (Not Used)**

**END OF SECTION 23 05 13**

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## SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 0010 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install expansion joints and pump connections as required by the drawings and this section.
- B. Any expansion indicated per plans has been based on steel pipe. If Contractor should choose to use an alternate approved material, he shall be responsible for any resulting changes in expansion.

#### 1.3 SUBMITTALS

- A. Submit manufacturer's catalog cuts and schedules for all mechanical joints and pump connectors.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Expansion Compensation Products
  - 1. Flexonics
  - 2. Metraflex
  - 3. Victaulic
  - 4. Minnesota Flexible
  - 5. Keflex
  - 6. Twin City Hose
  - 7. Mason Industries

#### 2.2 HYDRONIC MAINS

- A. Mechanical Expansion Compensator for 2" diameter and smaller steel pipe: Externally pressurized, all metal stainless steel bellows, carbon steel shroud and end fittings, internal guides and internal anti-torque device. Pressure rating of 175 psi at 750 deg F. Metraflex Model HP.
- B. Mechanical Expansion Compensator for 2" diameter and smaller copper pipe: Externally pressurized, all bronze with either stainless steel or bronze bellows, brass or copper shroud and end fittings, internal guides and internal anti-torque device. Pressure rating of 150 psi at 400 deg F. Metraflex Model HPPF.
- C. Mechanical Expansion joint for 2-1/2" diameter and larger: Self equalizing, ring controlled bellows, carbon steel shroud and end fittings, internal guides and internal anti-torque device. Rated for 300 psi maximum working pressure at 500 deg F maximum operating temperature. Metraflex Model MC.
- D. Pipe Guides: Pre-insulated alignment guides, Keflex series CP.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Provide for taking up expansion in hot water and steam mains and risers by means of installing loops, bends and mechanical expansion joints.
- B. Use swing or swivel joints for connections from mains to risers and from risers to coils and equipment connections. Cold spring pipe during installation at points of bends or offsets.
- C. Install anchoring as required for controlling expansion. Structural members for anchoring shall be firmly embedded or fastened into building members and shall withstand force of pipe expansion without straining building structure.
- D. Where expansion joints and/or loops are installed, piping shall be properly guided and anchored as recommended by expansion joint manufacturer. For chilled water systems or two-pipe heating/cooling systems, all pipe alignment guides to be preinsulated by factory. Keflex Series CP.

**END OF SECTION 23 05 16**

## SECTION 23 05 19 - METERS AND GAUGES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install meters and gauges as required by the drawings and this section.

#### 1.3 SUBMITTALS

- A. Submit manufacturer's catalog cuts showing complete descriptive data.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Thermometers
  - 1. Weiss 9VU35 (Base Specification)
  - 2. Dwyer
  - 3. Taylor
  - 4. Weksler
  - 5. U.S. Gauge
  - 6. Trerice
  - 7. Miljoco
  
- B. Gauges (For Water or Steam)
  - 1. Weiss Series LF402 (Base Specification)
  - 2. Dwyer
  - 3. Taylor
  - 4. Weksler
  - 5. U.S. Gauge
  - 6. Trerice
  - 7. Miljoco

#### 2.2 THERMOMETERS

- A. 9" "Adjust-Angle" industrial thermometer complete with double thick glass front, red reading, separable socket and arranged so the unit can be set at any required angle front to back or left to right during or after installation. Range 30-180 deg. F for hot water, and 0-120 deg. F for chilled water.

## **2.3 GAUGES**

- A. Weiss Series 4" liquid filled compound pressure-vacuum gauge with snubber, stainless steel case, white dial, 1/4" male NPT.
  - 1. Hydronic systems – typical range to be 30" vacuum to 100 lb. pressure. For systems with a fill pressure greater than 30 psi (e.g. multi-story buildings, refer to Expansion Tank Schedule), extend range as necessary to account for fill pressure plus scheduled pump head.
  - 2. For outside applications use silicon filled gauge.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install thermometers in discharge and return piping at boilers, heat exchangers, and chillers, at each supply and return connection for large heating and cooling coils and at other points as indicated on the drawings.
- B. Provide a 1/4" ball valve upstream of all gauges.
- C. Install gauge for each pump, mounted on 1/4" copper tube manifold connected to the suction and discharge of the pump, with ball valves in the manifold on each side of the gauge, so that the gauge may be opened to either the suction or discharge pressure.
- D. Install gauges on boiler and heat exchanger headers, at pressure reducing valves and at other points as indicated on drawings.

**END OF SECTION 23 05 19**

## SECTION 23 05 23 - GENERAL DUTY VALVES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install valves as required by the drawings and this section.

#### 1.3 SUBMITTALS

- A. Submittal data shall include physical dimensions, construction materials, and pressure and temperature ratings.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Gate Valves, Globe Valves

1. NIBCO
2. Powell
3. Milwaukee
4. Watts
5. Apollo Valves
6. Victaulic
7. Gruvlok

- B. Check Valves

1. NIBCO
2. Powell
3. Watts
4. Milwaukee
5. Apollo
6. Metraflex
7. Victaulic
8. Gruvlok

- C. Butterfly Valves

1. NIBCO
2. ABZ
3. Milwaukee
4. Watts
5. Apollo Valves
6. Victaulic
7. Gruvlok

D. Ball Valves

1. Watts LFB-6080/6081
2. Milwaukee BA-400S/BA450S
3. NIBCO T/S 585-70-66
4. Apollo 77C-140/240
5. Victaulic
6. Gruvlok

E. Polypropylene and/or PVDF Ball Valves

1. R&G Sloan - PPRO-Seal
2. ASAHF
3. Enfield
4. ASAHI/American
5. NIBCO/Chemtrol S61TBV/S62TBV and/or S65TBV

F. Refrigerant Ball Valves

1. Apollo 79-700 Series
2. Mueller Streamline Cyclemaster Series

G. All valves of same type shall be of the same manufacturer unless otherwise specified in this section or on the drawings.

**2.2 VALVE CONSTRUCTION**

- A. Gate valves shall have solid tapered wedge, except where otherwise specified. Valves on steam service 4" and larger shall have 1/2" (minimum) bypass valve and piping.
- B. Globe valves shall have renewable composition discs as recommended by manufacturer for intended service, or renewable bevel seats and metal discs. Valves on steam service 4" and larger shall have 1/2" (minimum) bypass valve and piping.
- C. Check Valves: Check valves 2" and smaller shall be horizontal swing type with bronze seat and composition of bronze disc as approved; body of same material, screwed or flanged and finish as adjoining globe or gate valve. Check valves 2" and larger installed at outlet of pumps shall be spring loaded silent type. Check valves 2-1/2" and larger shall be, flanged silent check type with bronze mounted bolted bonnet and renewable seat and disc, ductile iron body, 150 psi at 366 deg F conforming to MSS SP-136. Grooved option: 2" and larger, ASTM A-536 black enamel coated ductile iron body, stainless steel non-slam disc or elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded in nickel seat, 300 psi rated.
- D. Ball Valves 2-1/2" and smaller: Full port, bronze two-piece with stainless steel ball, teflon seats and stuffing box ring, vinyl insulated lever handle. Grooved option: ductile iron body, stainless steel ball and stem, TFE seats with fluoroelastomer seals.
- E. Butterfly Valves 2-1/2" and larger: ASTM A536 ductile iron body with aluminum bronze disc, EPDM or BUNA N seat, 416 stainless steel stem with gear box operator and extended neck. Grooved Option: Black enamel coated ductile iron body conforming to ASTM A536. Nickel plated ductile iron disc with blowout proof 416 stainless steel stem and EPDM seat.
- F. Refrigerant Ball Valves 2-5/8" and smaller: Brass two-piece full port with chrome plated ball, teflon seats, triple sealed stem, and brass cap. Valve shall be hermetic welded.



**2.3 VALVE SCHEDULE**

A. Furnish valves as per the following schedule:

<u>Service</u>	<u>Valve type</u>
Cooling/heating water, pressures up to 200 psi, temperatures from 40 deg. F to 250 deg. F.	Ball - 2-1/2" and smaller, NIBCO FP600A Butterfly - 2-1/2" and larger, NIBCO LD2000-3/5  Swing Check - 2" and smaller, 413B 2-1/2" and larger, NIBCO F918 Silent Check - 2" and larger, Temp < 180 deg. F- NIBCO 910-W, W-910-W, Or W-920-W Temp > 180 deg. F-910-B, W-910-B
Refrigerant lines	Ball - 2-5/8" and smaller, Apollo 79-700

B. Valves installed on all systems with insulated piping shall be provided with valve handle extensions and/or extended neck design to facilitate installation of insulation and make handles operable without damage to the insulation.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install valves as indicated on the drawings and as called for in other sections.
- B. Install valves in equipment rooms to provide easy access to valve. Each valve installed 8'-0" above the floor shall be provided with chain operator. Bottom of chain operator shall be 7'-0" above floor.
- C. Check valves shall not be installed in vertical runs of piping unless they are specifically designed for vertical operation.
- D. Gate valves shall be installed in horizontal pipes with the valve stem in the vertical up position. Rotate valve stem only as allowed by the manufacturer's installation instructions.

**END OF SECTION 23 05 23**

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## **SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED WORK**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### **1.2 DESCRIPTION OF WORK**

- A. Provide materials, equipment, labor and supervision necessary to install hangers, supports, anchors, guides and seals as required by the drawings and this section.
- B. Types of supports, anchors and seals specified in this section include the following:
  - 1. Horizontal Piping Hangers and Supports.
  - 2. Vertical Piping Clamps.
  - 3. Hanger Rod Attachments.
  - 4. Building Attachments.
  - 5. Saddles and Shields.
  - 6. Miscellaneous Materials.
  - 7. Anchors.

#### **1.3 QUALITY ASSURANCE**

- A. Code Compliance: Comply with applicable plumbing and mechanical codes pertaining to product materials and installation of supports, anchors and seals.
- B. UL and FM Compliance: Provide products which are Underwriters Laboratories listed and Factory Mutual approved.
- C. ANSI Compliance: All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0 except as supplemented or modified by the requirements of this specification.

### **PART 2 - PRODUCTS**

#### **2.1 HANGERS, SUPPORTS AND ACCESSORIES (Reference Catalog Figure numbers from Anvil)**

- A. Pipe support systems shall secure pipes in place, prevent pipe vibration, provide vertical adjustment for maintaining required grades, and provide for expansion and contraction.
- B. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- C. Wherever possible, pipe attachments for horizontal piping shall be pipe clamps.
- D. Wherever possible, structural attachments shall be beam clamps.

- E. All rigid hangers shall provide a means of vertical adjustment after erection.
- F. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- G. Where horizontal piping movements are greater than 1/2 inch, or where the hanger rod angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger pipe and structural attachments shall be offset in such manner that the rod is vertical in the hot position.
- H. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- I. Where supports are attached to concrete or other structural members, care shall be taken to prevent damage or weakening of the structural members.
- J. Where concrete inserts are used, it shall be the Contractor's responsibility to accurately locate and attach inserts to concrete forms.
- K. Hangers and supports for insulated cold piping shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, (Fig. 167) in conjunction with hanger or roll device
- L. Hangers and supports that are in direct contact with copper piping shall be copper plated or have nonmetallic coating for electrolytic protection.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION HORIZONTAL PIPE SUPPORT**

- A. Steel and copper pipe shall be supported at a maximum span of 10 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight. For 1/2 in. copper tube, maximum spacing shall be 8 feet.
- B. Plastic pipe (PVC, CPVC, polyethylene, etc.) shall be supported at a maximum span of 4 feet for all pipe sizes, with hanger rods sized accordingly for total supported weight.
- C. In addition to the above specified spacings, install additional hangers at change in pipe direction and at concentrated loads, large valves, strainers, etc.
- D. When two or more pipes are to be run parallel together, they may be supported on trapeze type hangers. Trapeze bar angles or channels and hanger rods shall be of sufficient size with required spacing to support the particular group of pipes.
- E. For suspending hanger rods from brackets attached to walls; use welded steel brackets, Fig 194 for loads up to 750 lbs; Fig. 195 for loads up to 1,500 lbs; Fig. 199 for loads up to 3000 lbs.
- F. Exterior refrigerant piping shall be supported with steel angle or steel channel strut supports as detailed on the drawings.
- G. Where pipes are to be racked along walls, use malleable iron one hole clamp, Fig. 126 for pipes up to 3". For pipes larger than 3", use steel channel strut pipe rack.
- H. Where pipes are to be supported from floor, use unistrut pipe stand with post base. Unformed concrete will not be permitted.

### **3.2 INSTALLATION VERTICAL PIPE SUPPORTS**

- A. Support vertical steel and copper pipe at every other floor line.
- B. In addition to the above, support vertical pipes at base of riser with base fitting set on concrete or block pier, or by hanger located on horizontal connection close to riser.
- C. Where pipe sleeves extend above floor, place pipe clamps at ceiling below and support clamp extensions from inserts or other approved attachment.

### **3.3 PIPE ATTACHMENTS**

- A. For horizontal steel pipe, use adjustable carbon steel clevis, Fig. 260, for pipes up to 30".
- B. For horizontal copper pipe and tube, use copper plated adjustable carbon steel clevis, Fig. CT 65.
- C. When thermal expansion for horizontal pipe is in excess of 1/2" axially as indicated on the drawing, use adjustable steel yoke pipe roll, Fig. 181, or pipe roll stand, Fig. 177.

### **3.4 INTERMEDIATE ATTACHMENTS**

- A. Hanger rods: use carbon steel single or double end threaded, Figs. 140 and 253 as required. Continuous threaded rod, Fig. 146, may be used wherever possible. Contractor may at his option cut and thread rod on the job site.
- B. Chain, wire or perforated strap hangers will not be permitted. One pipe shall not be suspended from another pipe.
- C. Hangers shall be supported from appropriate structural members. In no case shall hangers be supported from ductwork, cable trays, piping, or other equipment. Existing hangers and supports shall not be used as supports for new hangers unless specifically designed as such, or additional loadings have been confirmed to be acceptable for existing supports.

### **3.5 STRUCTURAL ATTACHMENTS**

- A. For attaching steel or copper plated hanger rods to reinforced concrete; use black carbon steel concrete inserts, Fig. 285 for loads up to 400 lbs., Fig. 281 for loads up to 1200 lbs. or suitable drilled inserts equal to Ramset/Red Head - Trubolt wedge anchor, Ramset/Red Head Epcon system or Hilti Kwik Bolt II anchor.
- B. For attaching steel hanger rods to structural steel beams, use malleable iron C clamps, Fig. 87, with retaining clip for loads up to 500 lbs.; Fig. 229 with extension piece for loads up to 1,365 lbs. For copper plated hanger rods, use copper plated malleable iron C clamps, Fig. CT 88, with hardened cup point set screw, for loads up to 400 lbs.
- C. For attaching steel hanger rods to wood structural members, use malleable iron ceiling flange pipe threaded, Fig. 128 for loads up to 480 lbs., Fig. 153 for loads up to 1270 lbs. For copper plated hanger rods, use copper plated malleable iron ceiling flange, Fig. CT 128R for loads up to 180 lbs.
- D. Under no circumstances shall hangers be attached to metal roof deck.

**3.6 PIPE AND DUCT COVERING PROTECTION**

- A. Hangers and supports for insulated cold piping and ductwork shall not injure or pierce insulation. Provide insulation protection shields or saddles for piping, Fig. 160, 161, 162, 163, 164, 165, 165A, 166A, or 167 in conjunction with hanger or roll device.

**3.7 ROOF MOUNTED PIPING AND EQUIPMENT**

- A. Roof mounted equipment, not specified to be mounted on roof curbs shall be installed on equipment mounting rails specifically designed for that purpose or as shown on plans.
- B. Roof mounted piping and ductwork shall be mounted on a pipe support system equal to B-Line C-Port.

**END OF SECTION 23 05 29**

**SECTION 23 05 48 - VIBRATION CONTROLS FOR HVAC PIPING, DUCTWORK AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 RELATED WORK**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

**1.2 DESCRIPTION OF WORK**

- A. Extent of vibration isolation work required by this section is indicated on drawings and schedules, and/or specified in other Division-23 sections.
- B. All HVAC equipment over one horsepower, unless otherwise noted shall be isolated from the structure by means of vibration and noise isolators.
- C. Where isolator type and deflection are not shown, the related equipment shall be isolated in accordance with the 2011 ASHRAE Handbook - HVAC Applications, Chapter 48.
- D. Types of vibration isolation products specified in this section include the following:
  - 1. Precompressed Molded Fiberglass Isolators.
  - 2. Elastomeric Isolators.
  - 3. Spring Isolators, Free Standing.
  - 4. Spring Isolators, Vertically-Restrained.
  - 5. Isolation Hangers.
  - 6. Structural Steel Bases.
  - 7. Concrete Inertia Bases.
  - 8. Isolation Rail Systems.
  - 9. Flexible Duct Connectors.
  - 10. Flexible Pipe Connectors.
- E. Vibration isolation products furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division-23 sections.
- F. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

**1.3 QUALITY ASSURANCE**

- A. Product Qualification: Provide each type of vibration isolation unit produced by specialized manufacturer, with not less than 5 years' successful experience in production of units similar to those required for project.
  - 1. The materials and systems specified in this Section shall all be provided by the Contractor, from a single vibration isolation materials manufacturer to assure single responsibility for the performance of all isolation materials.

## 1.4 SUBMITTALS

- A. The isolator manufacturer's submittal shall include the complete design for required isolation and bases, and a tabulation of the design data including O.D., free and operating heights of the isolators.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Vibration Isolation Products
  - 1. Kinetics Noise Control, Inc.
  - 2. Vibration Eliminator Co., Inc.
  - 3. VMC Group
  - 4. Mason Industries
- B. Flexible Pipe Connectors
  - 1. Keflex
  - 2. Metraflex
  - 3. Twin City Hose
  - 4. Minnesota Flexible
  - 5. Mason Industries
- C. The following item specifications apply to the corresponding Type numbers used in the Vibration Isolation Schedule. Model types are based on the 2011 ASHRAE Handbook - HVAC Applications, Chapter 48.

### 2.2 ISOLATION MATERIALS AND SUPPORT UNITS

- A. Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have  $k_x/k_y$  ratios of at least 0.9. All springs shall be fully color-coded to indicate capacity – color striping is not considered adequate.
- B. Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule.
- C. Base Types
  - 1. Type A Bases - no base required. Isolators may be attached directly to the supported equipment.
  - 2. Type B Bases - Steel Equipment Bases: Bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.
    - a. Vibration bases for fans shall have adjustable motor slide rails as indicated on their Schedule, and shall accommodate motor overhang.
    - b. Bases for exterior use shall be painted or hot-dipped galvanized for complete corrosion resistance.
    - c. Minimum clearance under steel equipment bases shall be 25mm (1”).



3. Type C Bases - Concrete Inertia Bases: Inertia bases shall be of welded steel construction with concrete in-fill supplied by the installing contractor on site and shall incorporate reinforcing bars, spaced 300 mm (12") maximum on centers each way.
  - a. Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections (if this information has been provided for configuration).
  - b. Inertia bases for fans shall include motor slide rails as indicated on their Schedule.
  - c. The weight of each inertia base shall be at least (1.5 times(x)) to the weight of the equipment mounted thereon or sufficient to lower the center of gravity to or below the isolator support plane.
  - d. Inertia bases shall be a minimum of 150 mm (6") thick.
4. Type D Bases: Isolation Rail System, consisting of two parallel aluminum rail systems with continuous neoprene air and water seal, incorporating steel spring isolators designed for one inch static deflection, all fabricated to be installed over the roof curb system, and provide continuous support for the isolated equipment.

#### D. Isolator Types

1. Type 1 Isolator - Rubber Pads and Glass Fiber Pads:
  - a. Isolation pads shall be single ribbed or crossed, double ribbed elastomer-in-shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All pads shall be true elastomer-in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI (176 kg/cm<sup>2</sup>) tensile strength, oil resistant compounds with no color additives. Pads shall be 45 to 65 durometer and designed to permit 60 or 120 PSI (4.2 or 8.4 kg/cm<sup>2</sup>) loading at maximum rated deflections. When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project bid documents, not exceeding published load capabilities.
  - b. Fiberglass continuous support material shall be high-density matrix of compressed molded fiberglass; individually coated with a flexible, moisture-impervious elastomeric membrane, designed to allow controlled air movement in the fiber media. It shall be manufactured in such a way that the pumping action of air between fibers provides viscous damping, reducing motion caused by transient shock and vibration. The material shall be non-corrosive, non-combustible, non-absorbent, and resists rust, ozone, mildew and fungus, vermin proof and it shall not shrink, swell, or decompose. Isolation characteristics of the media shall be constant over a temperature range of -40°F to 250°F (40°C to 121°C).
2. Type 2 Isolators - Rubber Mounts and Hangers:
  - a. Vibration isolators shall be neoprene, molded from oil-resistant compounds, with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capabilities.
  - b. Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding .40" shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected

to operate within its published load range. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit.

3. Type 3 Isolators - Spring Isolators and Hangers:
  - a. Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock nut and washer for attachment to the supported equipment. The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.
  - b. Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding .4", shall be hangers consisting of a free-standing, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. The spring element shall meet all the specified characteristics described in above. The stamped or welded hanger bracket shall meet all the specified characteristics described above. Shall also be fitted with a self-centering load cap for the hanger rod.
4. Type 4 Isolators - Restrained Spring Isolators: Vibration isolators for equipment which is subject to load variations and large external or torquing forces shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure. Housing shall be hot dipped galvanized. Spring elements shall meet all the specified characteristics described above.
5. Type 5 Isolators - Thrust Restraints: Provide in pairs. Locate on centerline of fan if possible. Bridge the flexible duct connector. Spring elements shall meet all the specified characteristics described above.

E. Flexible Piping Connectors:

1. Hydronic Systems:
  - a. Minimum ratings shall be 200 psi at 220 deg F.
  - b. Size 1-1/4" and smaller: Single sphere connector of neoprene and Kevlar tire cord fabric. Bead wires to prevent pull out. Basis of design: Mason Industries Type SFU.
  - c. Size 1-1/2" and larger: Twin sphere connector constructed of neoprene and Kevlar tire cord reinforcement. The raised rubber flanges must encase solid steel rings to prevent pull out. Flexible cable is not acceptable. Basis of design: Mason Industries Type SFDEJ.

2. Exterior Piping for Hydronic Systems:
    - a. Minimum ratings shall be 400 psi at 250 deg F.
    - b. Construction shall be 316L stainless steel hose with 304 stainless steel double braid to withstand the effects of potential flashing.
  3. See Section 23 21 23 – Hydronic Pumps for pump connector specifications.
- F. Flexible Ductwork Connectors:
1. Ventfabrics, Inc. Ventglas or equal.
  2. Flexible neoprene or heavy glass fabric duct connector with minimum material thickness of 0.024" and weight of 30 oz/sq. yard.
  3. Minimum temperature range shall be 30 to 200 deg F.
  4. The materials shall have a flame spread rating below 25 and smoke development rating below 50.
  5. The minimum static pressure rating shall be 10".

### **PART 3 - EXECUTION**

#### **3.1 PERFORMANCE OF ISOLATORS**

- A. General: Comply with minimum static deflections recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, including definitions of critical and noncritical locations, for selection and application of vibration isolation materials and units as indicated.
- B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

#### **3.2 APPLICATIONS**

- A. General: Apply types of vibration isolation materials and units indicated at locations shown or scheduled. Selection is Installer's option where more than one type is indicated.
- B. Piping Isolation:
  1. Piping over one-inch diameter and piping three supports away from rotating or reciprocating HVAC equipment shall be isolated from the structure by means of vibration and noise isolators.
  2. Suspended piping shall be isolated with Type 2 or Type 3 Hangers described herein.
  3. Floor mounted piping shall be isolated with Type 2 or Type 3 Isolators described herein.
  4. Minimum deflection shall be equal to the deflection of the equipment the piping connects to for the first three supports near the equipment; all other isolators shall be 1.00".
  5. Flexible piping connectors shall be incorporated in the piping adjacent to all reciprocating, compressorized, and/or rotating equipment and pumps, unless noted otherwise.
    - a. Chillers and cooling towers shall have flexible pipe connectors.
    - b. See Section 23 21 23 – Hydronic Pumps for pump connector specifications. Flexible pipe connectors not required at in-line pump installations.
    - c. Flexible pipe connectors are not required at main air handling unit water coils, zone level terminal units, condensate pumps, and split systems.

- C. Duct Isolation:
  - 1. High velocity ductwork, for a distance of 50 feet from high pressure fans, shall be isolated from the structure by means of Type 2 or Type 3 Hangers described herein.
  - 2. Minimum deflection shall be equal to the deflection of the equipment the ductwork connects to for the first three supports near the equipment; all other isolators shall be 1.00".
  - 3. Flexible ductwork connectors shall be incorporated in the ductwork adjacent to all air moving units, unless noted otherwise.
    - a. Flexible duct connectors are not required at boiler intake/flues or hood exhaust fans.

### **3.3 INSTALLATION**

- A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.
- B. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.
- C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
- D. Locate isolation hangers as near overhead support structure as possible.
- E. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.
- F. Flexible Pipe Connectors: Install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

### **3.4 EXAMINATION OF RELATED WORK**

- A. Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish written report to Contractor listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:
  - 1. Equipment installations (performed as work of other sections) on vibration isolators.
  - 2. Piping connections including flexible connections.
  - 3. Ductwork Connections including provisions for flexible connections.
  - 4. Passage of piping and ductwork which is to be isolated through walls and floors.
- B. Do not start up equipment until inadequacies have been corrected in manner acceptable to vibration isolation Installer.

**END OF SECTION 23 05 48**

## **SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED WORK**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### **1.2 DESCRIPTION OF WORK**

- A. Extent of identification work required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Type of identification devices specified in this section include the following:
  - 1. Painted identification materials
  - 2. Plastic pipe and duct markers
  - 3. Plastic tape
  - 4. Valve tags
- C. Identification furnished as part of factory fabricated equipment, is specified as part of the equipment assembly in other Division 23 sections.

#### **1.3 QUALITY ASSURANCE**

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

#### **1.4 SUBMITTALS**

- A. Schedules: Submit valve schedule for each piping system, formatted in an Excel spreadsheet with a digital copy provided to the Owner along with a printed copy on 8 1/2" x 11" paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut off and similar special uses, by special "flags", in margin of schedule. In addition, furnish extra copies for Maintenance Manuals.
- B. Labeling Nomenclature: Submit list indicating system types with appropriate nomenclature to be provided on the pipe and duct labels. Where possible, match to system labels on drawings.

### **PART 2 - PRODUCTS**

#### **2.1 IDENTIFICATION MATERIALS**

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than one single type is specified for an application, selection is Installer's option, but provide single selection for each product category.

B. Plastic Pipe and Duct Markers:

1. General: Provide manufacturer's standard pre printed flexible or semi rigid, permanent, color coded, plastic sheet pipe and duct markers.
2. Color: Color of pipe and duct markers shall comply with ANSI A13.1.
3. Color: Color of pipe and duct markers shall comply with the table below:

System	Background	Lettering
Supply Air	Blue	White
Return Air	Gray	White
Exhaust/Relief Air	Black	White
Outside Air	Green	White
Chilled Water Supply/Return	Dark Blue	White
Condenser Water	Aluminum	Black
CT Makeup Water	Light Blue w/ Alum. Band	Black
Heating Water Supply/Return	Medium Blue	White

4. Small Pipes: For external diameters not greater than 6" (including insulation if any), provide full band pipe markers extending 360 degrees around pipe at each location, fastened by one of the following methods:
  - a. Snap on application of pre tensioned semi rigid plastic pipe marker.
  - b. Adhesive lap joint in pipe marker overlap.
  - c. Laminated or bonded application of pipe marker to pipe (or insulation).
  - d. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 3/4" wide full circle at both ends of pipe marker, tape lapped 1 1/2".
5. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full band or narrow strip type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
  - a. Laminated or bonded application of pipe marker to pipe (or insulation).
  - b. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
  - c. Strapped to pipe (or insulation) application of semi rigid type, with manufacturer's standard stainless steel bands.
6. Ducts: Provide either full band or narrow strip type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
  - a. Laminated or bonded application of marker to duct (or insulation).
  - b. Taped to duct (or insulation) with color coded plastic adhesive tape, not less than 1 1/2" wide; full circle at both ends of marker, tape lapped 3".
  - c. Install labels on all ductwork in mechanical rooms and in areas outside of the mechanical room unless specifically noted otherwise. Labels shall be placed at maximum intervals of 20 feet and near all branch take-offs and shall included the connected equipment (AHU, EF, etc.) and system type per the colors defined above.
7. Lettering: Manufacturer's standard pre printed nomenclature which best describes piping system in each instance, as selected by Design Professional in cases of variance with names as shown or specified.
8. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

- C. Plastic Tape:
  - 1. General: Manufacturer's standard color coded pressure sensitive (self adhesive) vinyl tape, not less than 3 mils thick.
    - a. Width: Provide 1 1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2 1/2" wide tape for larger pipes or ducts.
    - b. Color: Same as indicated for Plastic Pipe or Duct Markers.
  
- D. Valve Tags:
  - 1. Brass Valve Tags: Provide polished brass valve tags with stamp engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 7/16" high, and with 3/16" hole for fastener. Tag thickness 0.040 inches.
    - a. Provide 2" diameter tags, except as otherwise indicated.
    - b. Fill tag engraving with black enamel.
  - 2. Plastic Valve Tags: Provide red heavy plastic tag with 7/16" white embossed sequenced numbers.
  - 3. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S hooks or heat sealed braided copper wire of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
  
- E. Name Plates:
  - 1. General: Provide manufacturer's standard preprinted plastic, brass, or aluminum with stamped, engraved or embossed letters.
  - 2. Lettering:
    - a. Large Equipment: 1 1/2" lettering as appropriate.
    - b. Small Equipment: 3/4" lettering as appropriate.
  - 3. Attachments: Mounting holes and screws, pressure sensitive adhesive backing, or solid brass chain.

## 2.2 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in HVAC identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of HVAC systems and equipment.
  - 1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

## PART 3 - EXECUTION

### 3.1 APPLICATION AND INSTALLATION

- A. General Installation Requirements:
  - 1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags, install identification after completion of covering and painting if any. Install identification prior to installation of acoustical ceilings and similar concealment.

B. Ductwork Identification:

1. Access Doors: Provide stenciled or plastic laminate type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.
2. Locate duct markers and color bands as follows wherever ductwork is exposed to view in unoccupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non concealed locations. Install markers such that lettering is visible from floor.
  - a. Near each control device.
  - b. Near each branch, excluding short take offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
  - c. Near locations where ducts pass through walls or floors/ceilings, or enter non accessible enclosures.
  - d. Near major equipment items and other points of origination and termination.
  - e. Spaced intermediately at maximum spacing of 20' along each duct run with a minimum of one marker in each room.
  - f. On ducts above removable acoustical ceilings.
3. Duct markers shall include AHU number (AHU-##), system, and flow direction arrows.

C. Piping System Identification:

1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
  - a. Stenciled markers, including color coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
  - b. Plastic pipe markers, with application system as indicated under "Materials" in this section.
  - c. Stenciled markers, black or white for best contrast, wherever continuous color coded painting of piping is provided.
2. Locate pipe markers and color bands as follows wherever piping is exposed to view in unoccupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non concealed locations. Install markers such that lettering is visible from floor.
  - a. Near each valve and control device.
  - b. Near each branch, excluding short take offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
  - c. Near locations where pipes pass through walls or floors/ceilings, or enter non accessible enclosures.
  - d. At access doors, manholes and similar access points which permit view of concealed piping.
  - e. Near major equipment items and other points of origination and termination.
  - f. Spaced intermediately at maximum spacing of 20' along each piping run with a minimum of one marker in each room.
  - g. On piping above removable acoustical ceilings.



D. Valve Identification:

1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, and shut off valves at terminal devices and similar rough in connections of end use fixtures and units. List each tagged valve in valve schedule for each piping system.

E. Equipment Identification:

1. General: Provide equipment identification for all equipment including air handling units, terminal units, fans, pumps, boilers, heaters, control panels, condensing units, and chillers.
2. Labeling: All equipment shall be labeled as per construction document plan marks or as designated by Owner.
3. Provide identification by means of nameplates as appropriate.
  - a. For equipment with factory furnished casing, identification shall be by adhesive fixed name plates.
  - b. Field insulated items, such as expansion tanks may be identified by plastic pipe markers.

F. Filter Identification:

1. All filter locations shall be provided with a permanent filter label indicating the size and quantity of filters required at that location. The label shall be legible, durable (phenolic or equivalent), and easily viewed when changing the filter. All filters shall be a standard size.

**END OF SECTION 23 05 53**

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## SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of testing, adjusting and balancing work is indicated by requirements of this section, and also by drawings and schedules, and is defined to include, but is not necessarily limited to, air and hydronic distribution systems, domestic water circulation and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (including pulley changes as required), adjustments of system components, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents. Entering, navigating the Building Automation System in order to adjusting 'K factors' and related items is also required.
- B. Component types of testing, adjusting and balancing specified in this section includes the following as applied to HVAC equipment:
  - 1. Air Systems:
    - a. Air Handling Units
    - b. Energy Recovery Units
    - c. Exhaust Fans
    - d. Ductwork Systems
    - e. Diffusers and Grilles
  - 2. Water Systems:
    - a. Pumps
    - b. Coils
    - c. HVAC Piping Systems
    - d. Domestic Hot Water Recirculating System
- C. The Heating and Air Conditioning Contractor shall provide a complete and operating HVAC system and shall cooperate with the balancing agency by:
  - 1. Installing balancing dampers as required by the Drawings and Specifications and requested by the Testing and Balancing Contractor.
  - 2. Putting complete system into operation during duration of balancing period.
  - 3. Providing up-to-date set of Drawings and advising immediately of any changes made to the system during construction.
  - 4. Providing labor and equipment and cost of performing corrections, such as dampers, belts, etc., as required without undue delay.
  - 5. Providing complete submittal information for all HVAC equipment, complete with pertinent engineering information.

### **1.3 REFERENCES**

- A. Associated Air Balance Council (AABC) - National Standards for Field Measurement and Instrumentation, Total System Balance.
- B. ASHRAE - HVAC Applications Handbook: Chapter 34, Testing, Adjusting and Balancing. (Most recent edition).
- C. National Environmental Balancing Bureau (NEBB) - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

### **1.4 QUALITY ASSURANCE**

- A. Tester: A firm with at least 3 years of successful testing, adjusting and balancing experience on projects with testing and balancing requirements similar to those required for this project, who is not Installer of system to be tested and is otherwise independent of project.
- B. TAB Agency Qualification: Current membership in AABC or certification by NEBB or SMACNA.
- C. Test Equipment Criteria: The basic instrumentation requirements and accuracy/calibration required by AABC, National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
- D. All testing and balancing contractors are to be approved by the Design Professional before bidding. The contractors approved to date are:
  - 1. Midwest Fluid Balancing  
LaCrosse, Wisconsin  
(608) 785-1135
  - 2. Environmental Systems Analysis, Inc.  
Madison, Wisconsin  
(608)221-8817
  - 3. Professional System Analysis, Inc.  
Germantown, Wisconsin  
(262) 253-4146

### **1.5 JOB CONDITIONS**

- A. Do not proceed with testing, adjusting and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.

### **1.6 SUBMITTALS**

- A. TAB Agency Qualifications: Submit names and qualifications of company officers and job supervisor. Submit list of proposed test equipment and sample report format indicating all measurements to be taken. These shall be submitted to and reviewed by Design Professional prior to commencing work.

- B. The test-and-balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the balancing agency's certified test-and-balance engineer.
- C. Submit electronic pdf file of the test-and-balance report to Design Professional.
- D. The report shall contain the required data in a format selected by Balancing Contractor.
- E. Report shall include the following information: (For all references to "design", specific information from shop drawings shall be incorporated.)
  - 1. Air Moving Equipment:
    - a. Location
    - b. Manufacturer and Model
    - c. Supply, return and exhaust, air flow, design and actual
    - d. Outside air flow, design and actual (where applicable)
    - e. Inlet, discharge, and total static pressure, design and actual
    - f. Full static pressure profile with measurements between all components through unit.
    - g. Fan RPM, design and actual
  - 2. V-Belt Drive:
    - a. Identification/location
    - b. Required driven RPM
    - c. Driven sheave, diameter and RPM
    - d. Belt, size and quantity
    - e. Motor sheave, diameter and RPM
  - 3. Duct Traverse:
    - a. System zone/branch
    - b. Duct size and area
    - c. Velocity and airflow, design and actual
    - d. Duct static pressure
    - e. Air temperature and correction factor (if applicable)
  - 4. Air Monitoring Station Data:
    - a. Identification/location
    - b. System
    - c. Size and area
    - d. Velocity and airflow, design and actual
  - 5. Air Terminal Unit Data:
    - a. Identification/number and location
    - b. Manufacturer and model
    - c. Size
    - d. Minimum static pressure, design and actual
    - e. Maximum air flows, design and actual
    - f. Minimum air flow, design and actual

6. Room Air Distribution Test Sheet:
  - a. Air terminal number
  - b. Room number/location
  - c. Terminal type and size
  - d. Area factor
  - e. Velocity, design and actual
  - f. Air flow, design and actual
  - g. Percent of design air flow
  - h. Air outlet differential pressure (for underfloor plenums)
  
7. Pump Data:
  - a. Identification/number
  - b. Manufacturer and model
  - c. Impeller size
  - d. Service
  - e. Flow rate, pressure drop, BHP, design and actual
  - f. Discharge suction and total pressure
  - g. Shut off, discharge, suction and total pressures
8. Central Station Cooling and Heating Coil Data:
  - a. Identification/number
  - b. Location and service
  - c. Air flow, design and actual
  - d. Entering and leaving air DB and WB temperatures, design and actual
  - e. Water flow and pressure drop, design and actual
  - f. Entering and leaving water temperature, design and actual
  - g. Air pressure drop, design and actual
  - h. Differential pressure across balancing valves.
  
9. Terminal Unit Heating and Cooling Coil Data
  - a. Identification/number
  - b. Manufacturer and model
  - c. Entering and leaving DB temperature, design and actual
  - d. Entering and leaving water temperature, design and actual
  - e. Water flow, design and actual
  - f. Differential pressure across balancing valves.
  
10. Water Flow Measuring Station:
  - a. Identification/station
  - b. Manufacturer and model
  - c. Location
  - d. Size
  - e. Flow rate and pressure drop, design and actual
  - f. Station calibrated setting
  
11. Electric Motors:
  - a. Manufacturer (1/4 hp and larger only)
  - b. HP/BHP, design and actual
  - c. Phase, voltage, amperage; design and actual

- d. Service factor
- e. Starter size, rating, heater elements (as applicable)

## **PART 2 - PRODUCTS**

### **2.1 PATCHING MATERIALS**

- A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jibs, and similar purposes.
  - 1. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

## **PART 3 - EXECUTION**

### **3.1 TESTING**

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester. Before initiating balancing work, Contractor shall verify that systems are complete and operable. Ensure the following:
  - 1. Equipment is operable and in a safe and normal condition.
  - 2. Temperature control systems are installed complete and operable.
  - 3. Proper thermal overload protection is in place for electrical equipment.
  - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - 5. Duct systems are clean of debris.
  - 6. Correct fan rotation.
  - 7. Volume dampers are in place and open.
  - 8. Coil fins have been cleaned and combed.
  - 9. Access doors are closed and duct end caps are in place.
  - 10. Air outlets are installed and connected.
  - 11. Duct system leakage has been minimized.
  - 12. Hydronic systems have been flushed, filled, and vented.
  - 13. Correct pump rotation.
  - 14. Proper strainer baskets are clean and in place.
  - 15. Service and balance valves are open.
- B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.
- C. Coordinate TAB procedures with any phased construction completion requirements for the project. Systems serving completed phases of the project will require TAB for such phases prior to partial final inspections.
- D. Allow sufficient time in construction schedule for TAB and submission of reports prior to partial final inspections.
- E. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards. Draft report shall be sent to Design Professional for review prior to issuance to Owner.

- F. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.
- G. Mark equipment settings, including damper control positions, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.
- H. Prepare a report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for HVAC work.
- I. The test and balance agency shall perform the following tests and balance the air system in accordance with the following requirements (provide written substantiating data):
  - 1. Test, adjust and record all blower RPM at design requirements.
  - 2. Make pitot tube transverse of main supply ducts and obtain design CFM at all fans and blowers.
  - 3. Test and record all system static pressures, suction and discharge.
  - 4. Test and adjust all systems for design CFM of recirculated air.
  - 5. Test and adjust all systems for design CFM of outside air.
  - 6. Test and record entering and leaving air temperatures (DB and WB); all air units.
  - 7. Adjust all zones to proper design CFM, supply and return.
  - 8. Test and adjust each diffuser, grille and register within 10% design requirements.
  - 9. In reading and tests of diffusers, grilles and registers, include design velocity and final velocity, when required, and design CFM and final CFM after adjustments.
  - 10. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
  - 11. In cooperation with the control manufacturer's representative, set adjustments of all controllers to operate as specified, indicated and/or noted.
  - 12. Flow Rate Tolerances:
    - a. Applications which do not require differential pressure control: -10% to +10%.
    - b. Applications which require differential pressure control:
      - 1) Positive zones
        - a) Supply air: 0 to +10%
        - b) Exhaust and return air: 0 to -10%
      - 2) Negative zones
        - a) Supply air: 0 to -10%
        - b) Exhaust and return air: 0 to +10%
    - c. Minimum outside air: 0 to +10%
  - 13. Coordinate locations of volume dampers with the mechanical contractor as required to balance the entire system.
- J. The test and balance agency shall perform the following tests and balance the water system in accordance with the following requirements (provide written substantiating data):
  - 1. Before setting pump capacities, check the following items:
    - a. Automatic fill valve setting and strainer
    - b. Expansion tank level
    - c. Cleanliness of system water
    - d. Make certain all pump strainers are clean



- e. Check air vents at coils and high points of system
  - 2. Measure circulating pump capacities by differential pressure measurements, amperage and brake horsepower method using the pump manufacturer's capacity curve. Position all automatic valves, hand valves and balancing cocks for full flow through coils, convertors, etc. during pump adjustment. Use only calibrated test gauges for pump adjustment; the use of pressure gauges installed with the system will not be allowed. Adjust triple duty valve as required to provide minimum differential pressure required for most remote automatic flow control valve.
  - 3. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
  - 4. Balance system with automatic control valves fully open to heat transfer elements. For coils with 3-way control valves, set bypass balancing cock to provide total flow when control valve is in 100% bypass position equal to total flow when control valve is 100% open to coil.
  - 5. Determine minimum differential pressure setpoint required to maintain flow at all water coils. Coordinate final setting with Temperature Control Contractor.
  - 6. Coordinate the setting of controls to maintain coil water inlet design temperatures, with coil valves positioned for full flow through coil during adjustment. Balance individual water coils at full flow to maintain temperature differential specified.
  - 7. Mark settings of all balancing cocks at required positions. Do not use service or shut-off valves for balancing unless indexed for balance point. For automatic flow control valves: Record differential pressure and verify within operating range of valve.
  - 8. Flow Rate Tolerances:
    - a. Two-pipe system pumps and coils: -10% to +10%
  - 9. Up to 10% of automatic flow control cartridges can be replaced by the mechanical contractor if required to achieve the specified pressure or flow. Coordinate with the mechanical contractor as required.
  - 10. Unless noted otherwise balance all domestic hot water circulation valves to 0.5 gpm.
- K. Where balancer has a question regarding appropriate system configuration for balancing, balancer should contact Design Professional for clarification.

**END OF SECTION 23 05 93**

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## SECTION 23 07 00 - HVAC INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install insulation to all hot and cold surfaces of piping, ductwork, tanks, fittings and other surfaces as required by the drawings and this section.
- B. Insulation shall include insulating materials, jackets, adhesive, mastic coatings, tie wire and other materials as required to complete the insulating work.

#### 1.3 DEFINITIONS

- A. Conditioned Space: An area inside the building which is heated and/or cooled.
- B. Tempered Space: An area inside the building which is not directly heated or cooled, but is adjacent to a heated or cooled space with no insulation separating the two spaces (e.g., ceiling plenums).
- C. Untempered Space: An area inside the building which is not conditioned and is not tempered (e.g., attic spaces).
- D. Exterior Space: An area outside the building including thickness of roof/insulation and exterior wall construction. (e.g., roof mounted items).

#### 1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Insulating materials, jackets, mastics, etc., shall meet flame spread and smoke developed ratings in accordance with NFPA-90A. Flame spread rating of not more than 25, smoke developed rating of not more than 50 as tested by ANSI/ASTM E84 (UL 723) (NFPA 255) method. All accessory items such as PVC jacketing and fittings, adhesive, mastic, cement tape and cloth shall have the same component ratings as specified above.
- B. Installation of insulation materials shall be in accordance to the latest edition of MICA/NIAC National Commercial & Industrial Standards for the appropriate material application.
- C. NFPA Compliance: Fire Barrier Duct Wrap systems shall meet requirements of NFPA 96 for grease duct application.

#### 1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type of HVAC insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each HVAC system requiring insulation.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- B. Protect insulation against dirt, water, and chemical and HVAC damage. Do not install damaged insulation; remove from project site.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Insulating Materials
  - 1. Owens/Corning Fiberglass Corp.
  - 2. Armacell.
  - 3. Pittsburgh Corning Corp.
  - 4. CertainTeed Corp.
  - 5. Knauf Fiber Glass
  - 6. John's-Manville Corp.
  - 7. Aeroflex
- B. Mastics and adhesives as recommended by insulation manufacturer.

### **2.2 PIPE INSULATION**

- A. Type 'A': Preformed sectional heavy density fiberglass insulation and factory applied vapor barrier, all service jacket with pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 0 to +850 deg. F. Thermal conductivity shall be no greater than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Owens Corning 25 ASJ/SSL.
  - 1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
  - 2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.
  - 3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016" aluminum jacket.
- B. Type 'B': Flexible elastomeric extruded pipe covering, 6 pound density, 0.27 K factor, water vapor permeance of 0.20 perms. Suitable for temperature from -40 deg. F to +220 deg. F. Equal to Armacell, AP Armaflex, joints sealed with adhesive as recommended by insulation manufacturer. Exposed outdoor insulation to be finished with two coats of ArmacellArmaflex WB Finish protective coating.
  - 1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
  - 2. Where insulation is exposed in indoor occupied space and within 8 feet of finished floor, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.
  - 3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016" aluminum jacket.

- C. Type 'C': Preformed rigid hydrous calcium silicate insulation. Mechanically fastened by wiring in place using 16 gauge wire on 9" centers and covered with suitable jacketing for indoor or outdoor application. Suitable for operating temperatures +200 to +1200 deg. F. Thermal conductivity shall be no greater than 0.42 Btu-in/hr-sq.ft.-deg F @ 200 deg. F mean temperature. Equal to Owens-Corning Kaylo asbestos-free pipe insulation.
- D. Type 'D': Preformed rigid cellular glass insulation with factory applied self-sealing jacket. Suitable for operating temperatures -200 to +900 deg. F. Thermal conductivity shall be no greater than 0.29 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Equal to Pittsburgh Corning Foamglas with Pittwrap SS Jacketing.
- E. Type 'E': Preformed sectional heavy density fiberglass insulation, absorbent hydrophilic wicking-cloth, and factory applied vapor barrier, all service jacket with evaporation holes aligned with inner wicking fabric and pressure sensitive self-sealing longitudinal laps and butt strips. Suitable for operating temperatures from 35 to +350 deg. F. Thermal conductivity shall be no greater than 0.23 Btu-in/hr-sq.ft.-deg F @ 75 deg. F mean temperature. Water vapor permeance of .02 perms. Equal to Knauf Fiber Glass PermaWick.

### 2.3 FITTING INSULATION

- A. Type 'A1': Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered with all-service jacket or low smoke PVC fitting covers. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket.
  - 1. Where insulation is exposed to weather outdoors it shall be covered with an aluminum or stainless steel weatherproof jacket 0.016" thick and sealed.
  - 2. Where insulation is exposed in indoor occupied space, it shall be covered with 30 mil PVC jacket equal to Johns Manville Zeston.
  - 3. Where insulation is exposed in a mechanical room and is within 6 feet of finished floor, it shall be covered with a 0.016" aluminum jacket.
- B. Type 'B1': Fittings: Insulate fittings, valve bodies, strainer bodies, etc., with mitercut pipe insulation or sheet insulation of same material as pipe covering.
- C. Type 'C1': Fittings: Insulate fittings with mitered segments of pipe insulation of same material as pipe covering, wired in place and finished with a 1/4" layer of insulating cement. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as pipe covering, wired in place and finished with 1/4" layer of insulating cement.
- D. Type 'D1': Fittings: Insulate fittings with mitered segments of pipe insulation of same material as pipe covering, wired in place and covered with suitable jacketing for indoor or outdoor application. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of the same insulating material as pipe covering, wired in place, and covered with suitable jacketing for indoor or outdoor application.
- E. Type 'E1': Fittings: Insulate with mitered segments of same insulating material as for adjacent pipe covering, or with pre-molded fiberglass wired in place and covered. Wrap all fittings with PermaWick absorbent fabric and cover with appropriate all-service jacket or Proto PermaWick PVC jackets with factory punched evaporation holes. Valve bodies, strainer bodies, flanges, etc.: insulate with single or multiple layers of same insulating material as for adjacent pipe covering, wired in place and covered with all-service jacket. Wrap all fittings with PermaWick absorbent fabric and cover with appropriate all surface jacket or Proto PermaWick PVC jackets with factory punched evaporation holes.

## 2.4 EQUIPMENT INSULATION

- A. Type 'G':
1. Rigid fiberglass insulation board with factory applied all service jacket. Suitable for operating temperatures of 0 to +850 deg. F. Water vapor permeance of .02 perms. Equal to Owens Corning Series 700 with 25 ASJ facing.
  2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. On round surfaces band insulation in place with 3/4" x 0.015" thick galvanized steel bands 18" on center. On flat or irregular surfaces impale insulation over welded pins on 12" centers and secure with speed washers.
  3. Apply vapor seal ASJ pressure-sensitive patches at damaged areas. All insulation edges and butt joints are to be sealed with pressure-sensitive joint sealing tape to match the jacket. Apply in accordance with manufacturers recommendations.
- B. Type 'H':
1. Rigid hydrous calcium silicate insulation. Suitable for operating temperatures of +200 to +1200 deg. F. Equal to Owens-Corning Kaylo asbestos free block insulation.
  2. Cut or miter insulation where necessary to fit the shape and contour of the equipment. Insulation shall be held in place with 3/4" x 0.015" thick galvanized steel bands 18" on center.
  3. Insulation shall be finished with 1/2" thickness of insulating cement, in two coats.
- C. Type 'I':
1. Flexible elastomeric insulation. Suitable for operating temperatures of -40 to +220 deg. F. Equal to Armacell Armaflex II Sheet Insulation.
  2. Cut insulation where necessary to fit the shape and contour of the equipment. Insulation shall be installed using Armstrong 520 Adhesive.
  3. Exposed outdoor insulation shall be finished with two coats of Armacell Armaflex finish.

## 2.5 DUCT INSULATION

- A. Duct Covering: Johns Manville Microlite Standard or equivalent fiberglass duct wrap with factory applied Foil Scrim Kraft (FSK) vapor barrier jacket, 1.0 pound per cubic foot density.
- B. Rigid Duct Covering: Johns Manville or equivalent semi-rigid fiberglass insulation board with a factory applied Foil Scrim Kraft (FSK) vapor barrier jacket, three (3) pound per cubic foot density. Exterior rigid duct insulation to be covered with VentureClad 1577CW multilayered, self-adhesive jacketing system.
- C. Exterior Duct Insulation:
1. Insulation board : Rigid closed cell polyisocyanurate foam with minimum nominal density of 2.0 lb/cu ft and thermal conductivity no higher than 0.19 at 75 deg F after 180 days and maximum water vapor permeability of 4 perm inch and maximum water absorption of 2% by volume. Insulation shall have minimum 24 psi parallel and 13 psi perpendicular compressive strength and rated for -250 deg F to 900 deg F.
  2. Jacket: Multi-layered self-adhesive water proof jacketing system. VentureClad 1577CW or equal.

## **2.6 INSULATION BLANKETS**

- A. Interior fabric properties: 17 oz/yd<sup>2</sup> silicone coated fiberglass cloth, temperature rating of -80 degrees F to 500 degrees F.
- B. Insulation filler properties: 1" thick (unless indicated otherwise) needled fiberglass mat insulation with 11.25 lbs/ft<sup>3</sup> density, maximum temperature rating 1,200 degrees F.
- C. Exterior fabric properties 17 oz/yd<sup>2</sup> silicone coated fiberglass cloth, temperature rating of -80 degrees F to 500 degrees F.
- D. Securement: Fourteen (14) gauge stainless steel lacing anchors with one and one half (1.5") diameter stainless steel speed washers.
- E. Sewing thread: Kevlar/stainless steel S-110 natural with stainless steel core. Steel core can withstand temperatures of approximately 1,100 degrees F, with mechanical strain.
- F. Draw cord closure: 0.125" diameter #4 ultra-strength draw cord.
- G. Identification tag: All reusable insulating blanket assemblies shall be labeled with a 1.5" x 3.5" aluminum or 304 stainless steel tag with raised imprinted lettering. The tagging systems shall facilitate installation and reinstallation of all blankets and enable replacements to be provided upon request by number assigned as imprinted on the label. Label shall include the building name (UI Museum of Art), mechanical room number, and equipment tag. Include example of planned labeling with submittal.
- H. Blankets shall be fully encapsulated and sewn, specifically shaped for the item it covers, and shall not be held together by hog ringing or wiring.
- I. Blankets shall utilize Teflon cloth belts, stainless steel double D-rings and/or Velcro straps.
- J. Blankets shall be easily removable and replaceable for maintenance.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Use only experienced applicators regularly engaged in the trade. Rough work will be rejected. Application details shall be in accordance with the insulating materials supplier's recommendations except where a higher standard is specified. All surface finishes shall be extended in such a manner as to protect all raw edges, cuts and surfaces of insulation.
- B. All piping shall be insulated unless specifically noted otherwise. Piping not noted in the table below shall be insulated with thicknesses matching ASHRAE 90.1 based on the fluid temperatures.

### **3.2 PIPE INSULATION INSTALLATION**

- A. Do not insulate the following:
  - 1. Valve bonnets
  - 2. Unions in hot piping
  - 3. TC valve operators

4. Hot piping within radiation enclosures or unit cabinet.
  5. Cold piping within unit cabinets provided piping is located over drain pan.
  6. Condensate piping between steam trap and union.
  7. Preinsulated expansion joints
- B. Insulate the following with insulation blankets:
1. Condensate chests, tanks, coolers, and receivers
  2. Chilled water meters
  3. Pumps
  4. Air separators
  5. Side stream filters
  6. Chiller evaporator
- C. Inspect all piping and equipment before applying insulation to ensure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
- D. Covering for "cold" pipes shall pass unbroken through hanger clevises, sleeves, etc. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided as required to prevent condensation. The same covering and hanging detail shall be used for pipes connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between pipes and hangers.
- E. Insulation at removable heads, strainer plugs, and other access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.
- F. Provide rigid insulation inserts at hangers for pipes sizes 2" and larger. Inserts shall be polyisocyanurate or calcium silicate, a minimum of 180 degrees and extend 2" beyond the hanger shield. Refer to MICA Plate 1-610. Wood or plastic block hanger inserts shall not be used.
- G. Use hydraulic insulating cement anywhere insulation fibers are exposed, to fill voids, and to repair damages to the factory applied vapor barrier. Finish with material matching or compatible with adjacent jacket material.

### **3.3 DUCT INSULATION APPLICATION**

- A. Unless specifically indicated to not be insulated, all ductwork and accessories shall be either lined or covered. Duct systems not listed or without a type or thickness indicated on the plans shall be insulated with 1-1/2" wrap.

### **3.4 DUCT COVERING INSTALLATION**

- A. Inspect all ductwork and equipment before applying insulation to ensure the installing contractor has completed all leak tests, and that all surfaces are clean, dry and ready for application of insulation.
- B. Covering shall be cut slightly longer than circumference of duct to insure full thickness at corners. All insulation shall be adhered with edges tightly banded, and shall be adhered to duct with fire resistant adhesive. Adhesive shall be applied so that insulation conforms to duct surfaces uniformly and firmly.



- C. In addition to the adhesive, the insulation shall be additionally secured to the bottom of all ducts 18" or wider by means of grip nails and speed clips. The protruding ends of the pins shall be cut off flush after the speed clips have been applied. The vapor barrier facing shall be thoroughly sealed with a vapor barrier mastic and tape where the pins have pierced through.
- D. Insulation for "cold" ducts and accessories shall pass unbroken through hangers, sleeves, fire dampers, flexible connectors, reheat coils, etc. as required to prevent condensation. All details of covering for cold surfaces shall be such that continuous covering with unbroken vapor barrier and uncompressed insulation is provided. The same covering and hanging detail shall be used for ducts connecting to vibrating equipment or carrying pulsating pressures to avoid metal contact between ducts and hangers. Insulation Contractor shall be responsible for coordination with equipment suppliers as required to ensure continuous covering of unlined equipment components, i.e. VAV terminal unit supply collar and exposed reheat coil u-bends, fan coil unit discharge, etc.
- E. Insulation at all access points shall be fabricated in such a manner that it can be readily removed without damage to the insulation. Removable insulation shall have a vapor proof cover fabricated so as to allow it to be resealed to the equipment vapor barrier.
- F. Exterior ductwork foam board insulation shall be installed in multiple layers with staggered joints/seams. Slope top insulation on top of rectangular ductwork to provide proper drainage as required by jacketing manufacturer.

### 3.5 PIPE INSULATION APPLICATION

\*\*\*\*\*NOTE: Not all services apply – refer to plans for scope of services. \*\*\*\*\*

<u>Service</u>	<u>Type Insulation and Thickness*</u>
<u>Above Ground Piping</u>  Hot water heating lines, supply and return, condenser water for building heating	Type A and A1: 1-1/4" and smaller - 1-1/2" thick 1-1/2" and larger - 2" thick  Type C and C1: 1-1/4" and smaller – 2-1/2" thick 1-1/2" to 6" - 3" thick 8" and larger – 4" thick
Chilled water, heat pump water lines, evaporator water, ground water, well water, system make-up water	Type A and A1: 6" and smaller – 1" thick 8" and larger – 1-1/2" thick  Type B and B1: 6" and smaller – 1" thick 8" and larger – 1-1/2" thick  Type E and E1: 6" and smaller – 1" thick 8" and larger – 1-1/2" thick
Heat recovery piping	Type A and A1: All pipe sizes - 1" thick
Condensing appliance flue pipe in un-heated spaces	Type A and A1: All pipe sizes – 1-1/2" thick

	Type B and B1: All pipe sizes – 1" thick
Low pressure steam (up to 15 psig)	Type A and A1: 1-1/4" and smaller - 1-1/2" thick 1-1/2" and larger - 2" thick Type C and C1: 1-1/4" and smaller – 2-1/2" thick 1-1/2" to 6" – 3" thick 8" and larger – 4-1/2" thick
Medium pressure steam (up to 60 psig)	Type A and A1: 3/4" and smaller - 1-1/2" thick 1" and larger - 3" thick  Type C and C1: 3/4" and smaller – 2-1/2" thick 1" to 1-1/4" - 4" thick 1-1/2" to 4" – 4-1/2" thick 5" and larger – 5" thick
High pressure steam (over 60 psig)	Type A and A1: 3/4" and smaller - 2-1/2" thick 1" to 3" - 3" thick 4" and larger – 4" thick  Type C and C1: 3/4" and smaller – 4" thick 1" to 3" – 4-1/2" thick 4" and larger – 6" thick
Steam condensate and pump discharge lines	Type A and A1: 1-1/4" and smaller - 1-1/2" thick 1-1/2" and larger - 2" thick  Type C and C1: 1-1/4" and smaller – 2-1/2" thick 1-1/2" to 6" – 3" thick 8" and larger – 4-1/2" thick
Condensate drain lines	Type A and A1: 1" thick for all pipe sizes.
Heat exchangers condensate receivers, air separators, Buffer Tank	Type G: 2" thick. Type H: 3-1/2" thick
Refrigeration piping	Type B and B1: 3/4" and smaller – 3/4" thick 7/8" to 1-5/8" – 1" thick 2-1/8" and larger – 1-1/2" thick
Chiller evaporator Chilled water or two-pipe system pump volutes	Type I – 1" thick

Generator/Engine Exhaust Piping	Type C and C1 2" thick for all pipe sizes
<u>Underground Piping</u> Hot water heating lines, supply and return	Type D and D1: 4" and smaller – 1-1/2" thick 6" to 14" – 2" thick 16" to 18" – 2-1/2" thick 20" to 24" – 3" thick
Low pressure steam	Type D and D1: 4" and smaller – 1-1/2" thick 6" to 14" – 2" thick 16" to 18" – 2-1/2" thick 20" to 24" – 3" thick
Medium pressure steam	Type D and D1: 4" and smaller – 1-1/2" thick 6" to 14" – 2" thick 16" to 18" – 2-1/2" thick 20" to 24" – 3" thick
High pressure steam	Type D and D1: 4" and smaller – 2-1/2" thick 6" to 8" – 4" thick 10" to 14" – 5-1/2" thick 16" to 18" – 6" thick 20" to 24" – 7" thick
Steam condensate and pump discharge lines	Type D and D1: 4" and smaller – 1-1/2" thick 6" to 14" – 2" thick 16" to 18" – 2-1/2" thick 20" to 24" – 3" thick
<p>* Insulation type and thickness indicated in table apply for all pipe materials.  **For piping exposed to outdoor ambient temperatures, increase thickness by 1/2"</p>	

**END OF SECTION 23 07 00**

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## SECTION 23 09 00 – BUILDING AUTOMATION SYSTEM (BAS)

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements Division 22 – Plumbing, Division 23 – HVAC, Division 26 – Electrical, Division 27 – Telecommunications, and Division 28 – Electronic Safety and Security are applicable to work required of this section.
- B. Coordination:
1. Coordination Required by BAS Contractor: The BAS Contractor shall provide all required information, material, direction and installation instructions to the designated contractor as required to allow this work to be completed in a timely/cost effective manner. This includes, but is not limited to, the following:
    - a. Coordinate with existing pneumatic controls system:
      - 1) The building is served by two pneumatic controls systems. One system serves the Courthouse end of the building with the head end control panel located in the maintenance shop. The second system serves the Law Enforcement Center (LEC) with the head end control panel located in the boiler room.
      - 2) The building construction sequencing will be done in Phases, so understanding how and when to remove the existing controls system without disruption to occupied spaces during construction is critical.
      - 3) The Law Enforcement Center will not be fully renovated, however the controls system will be a full upgrade. This will require existing pneumatic actuated devices that are to remain to be revised to DDC controlled devices. Coordination and replacement of control valve actuators, damper actuators room thermostats, etc is required.
      - 4) BAS Contractor to review existing HVAC systems that are remaining and identify how the existing system is controlled and write the same control sequence in the new DDC controls BAS.
      - 5) BAS Contractor to coordinate with all trades and understand the phasing of the project.
    - b. Coordinate with General Contractor prior to the start of construction:
      - 1) Locations of all sensors and devices located in CMU walls, concrete walls, concrete slabs, pre-cast walls, etc. Where shop drawing(s) are provided for these items, the locations shall be shown on the submitted shop drawing(s).
    - c. Coordinate with the HVAC and Plumbing Piping Contractor prior to the installation of piping on site:
      - 1) Locations of and pipe size transitions for all sensors, control valves, etc., ensuring accurate readings/operation and required access.
      - 2) Locations of flow measuring stations meeting the installation requirements for straight lengths of pipe upstream and downstream of the WFMS for the specific piping arrangement.
    - d. Coordinate with Sheet Metal Contractor prior to the submittal of ductwork shop drawings:
      - 1) Locations of all sensors, dampers, etc., ensuring accurate readings/operation and required access.
      - 2) Locations of airflow measuring stations (AFMS) meeting the installation requirements for straight lengths of duct upstream and downstream of the AFMS for the specific ductwork arrangement.

- e. Coordinate with Testing and Balancing Contractor:
    - 1) Provide support and coordination with Testing and Balancing (TAB) Contractor for all interfaces between controls and TAB scope of work. Provide all devices and timely access to the BAS for TAB Contractor use in completing TAB procedures.
  - f. Coordinate with Electrical Contractor:
    - 1) Quantities and locations for line voltage power requirements for powering BAS panels and devices.
    - 2) If additional line voltage power is required for the operation of the BAS beyond the scope shown on the plans, it is the BAS Contractor's responsibility to provide the additional power; however, this work shall be performed by a qualified Electrical Contractor in accordance with the requirements of Division 26 specifications and included in the BAS Contractor's bid.
    - 3) Quantities and locations of additional junction boxes required for controls components installed in electrical wiring systems (e.g. current sensor, relays, etc.).
  - g. Coordinate with Telecom Contractor:
    - 1) Quantities and locations of information outlet(s).
    - 2) If additional information outlets are needed beyond the quantity shown on the plans, it is the BAS Contractor's responsibility to provide these additional outlets. This work shall be performed by a qualified Telecom Contractor in accordance with Division 27 specifications and included in the BAS Contractors bid.
  - h. Coordinate with Fire Alarm Contractor:
    - 1) Quantities and locations for all points of connection between the BAS and fire alarm system.
  - i. Coordinate with Commissioning Agent:
    - 1) Provide support and coordination with Commissioning (Cx) Agent for all commissioning activities. Provide timely access to the BAS for Commissioning Agent use in completing commissioning procedures. Correct any deficiencies discovered during the commissioning process.
2. Work by Others: The following incidental work shall be furnished by the designated under the supervision of the BAS Contractor.
- a. HVAC and Plumbing Piping Contractor shall:
    - 1) Install automatic valves, wells, flow switches, and water flow measuring stations that are specified to be supplied by the BAS Contractor.
    - 2) Install all pipe mounted BAS items including wells, paddle switches and differential pressure switches, including their isolation valves and associated tubing.
  - b. Sheet Metal Contractor shall:
    - 1) Install all automatic dampers furnished by the BAS Contractor. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper actuators.
    - 2) Provide necessary blank off plates or ductwork transitions required to install dampers that are smaller than the duct size.
    - 3) Provide access door or other approved means of access through ducts for service to control equipment.

## **1.2 DESCRIPTION OF WORK**

- A. Contractor shall furnish and install a complete fully functioning BAS including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification and on the plans. The BAS Contractor shall include all items not specifically itemized in these specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these specifications. The BAS shall be a complete system designed for use on Intranets and the Internet. Contractor shall be responsible for coordination with the Owner without disruption to any of the other activities taking place on that LAN.
- B. The BAS shall possess a fully modular architecture, permitting expansion in the future through additional controllers, sensors, actuators, etc.
- C. Manage and coordinate the BAS system work in a timely manner in consideration of the project schedule. Coordinate cooperatively with the associated work of other trades so as to assist the progress and not impede or delay the work of associated trades.

## **1.3 QUALIFICATIONS**

- A. The control system shall be installed by competent control mechanics and electricians employed by the BAS Contractor. BAS Contractor is responsible for all work performed by their subcontractors.
- B. All bidders must be BAS Contractors in the business of installing direct digital control building automation systems for a minimum of 3 years. BAS Contractors must also have a minimum of five completed projects of similar size and complexity that have been in operation at least one year with the product line that will be used on this project. Any request for substitution must include a list of projects and completion dates to demonstrate compliance with this requirement.
- C. The BAS system shall be provided by a single source manufacturer offering a full line of controllers. This system shall be furnished, engineered, and installed by the manufacturer's local branch office or the manufacturer's locally authorized representative. BAS Contractor shall have factory trained technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.
- D. Control system components shall be the manufacturer's latest standard of design at the time of bid and in conformance with the following applicable standards for products specified.

## **1.4 QUALITY ASSURANCE**

- A. The building automation system and components shall meet the following regulatory requirements:
  - 1. American Society for Testing and Materials, ASTM.
  - 2. Institute of Electrical and Electronic Engineers, IEEE.
  - 3. National Electrical Manufacturers Association, NEMA.
  - 4. Electronics Industries Alliance, EIA.
  - 5. National Fire Protection Association, NFPA.
  - 6. National Electrical Code, NEC.
  - 7. American Society of Heating, Refrigeration, and Air-Conditioning Engineers, ASHRAE, (ASHRAE Standard 135 The BACnet Standard).
  - 8. American National Standards Institute, ANSI (ANSI 568 Commercial Building Telecommunications Cabling Standard).

9. Underwriters Laboratory, UL (UL 916 Energy Management Systems).
10. Underwriters Laboratory, UL (UL 864 Supervised Smoke Control).
11. FCC Regulation, Part 15.
12. Local building codes.

## 1.5 SUBMITTALS

- A. The following shall be submitted for approval prior to commencing construction of the BAS:
  1. Contractor Qualifications: Document compliance with qualification requirements listed above. Include names, email addresses, and phone numbers of the project manager, primary programmer, electrical sub-contractor, and other team members.
  2. BAS Design Submittal, including:
    - a. A bookmarked PDF with bookmarks for each plan sheet with title and number, each schedule, and each product cut sheet with appropriate description.
    - b. A table of contents listing sheet titles and sheet numbers.
    - c. A floor plan showing the proposed locations of all network controllers.
    - d. BAS network architecture diagrams including all controllers, repeaters, gateways, interconnections, etc.
    - e. Calculations showing that system architecture can support the minimum trending and data storage requirements of the project with a written guarantee that the final installation will meet the project trending and storage requirements.
    - f. Schematics with accurate arrangement of devices as they relate to the equipment.
    - g. Sequences and points lists as intended to be installed and programmed. A direct copy of the sequences and points lists from the plans will not be acceptable.
    - h. Points schedule for each physical point shown on the schematics, including: tag, point type, system name and display units.
    - i. Point-to-point wiring diagrams including start-stop arrangement for each piece of equipment, equipment interlocks, controller wiring terminal numbers and any special connection information required for properly controlling the HVAC equipment.
    - j. Controller schedule, including quantity, part number, description, and optional features.
    - k. Control damper schedule including a separate line for each damper and a column for each of the damper attributes, including: associated system, associated equipment, part number, fail position, damper type, damper operator, blade type, bearing type, seals, duct size, damper size, damper material, mounting, and actuator type.
    - l. Control valve schedules including a separate line for each valve and a column for each of the valve attributes: associated system, associated equipment, part number, configuration, fail position, pipe size, valve size, valve type, valve material, close off pressure, capacity, valve CV, calculated CV, design pressure, actual pressure, and actuator type.
    - m. Airflow measuring station schedules including a separate line for each AFMS and a column for each of the AFMS attributes: associated system, associated equipment, part number, type, duct/fan inlet size, AFMS material, velocity range, and design airflow.
    - n. Product cut sheets including manufacturer's catalog data describing each item of control equipment or component provided and installed for the project. Cut sheets shall include performance data as applicable (e.g. valve Cv, damper pressure drops, operating range, sensor accuracy, sensor units, sensor, sensor hysteresis, sensor stability, etc.).
    - o. Product cut sheets for the operator workstation and any data storage devices including all technical specifications.



- B. The following shall be submitted for approval a minimum of two months prior to substantial completion:
  - 1. Floor plan graphics.
  - 2. One sample graphic of each different equipment arrangement included on the project. Graphics that are not identical (except for equipment labels) need to be submitted as separate graphics.

## **1.6 SOFTWARE LICENSES**

- A. Provide required copies of all licenses for software, including software licenses on local workstations and software loaded or embedded into controllers or other network devices. BAS licensing shall allow for unlimited access to the system; no restrictions shall be placed on the licensing. All software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

## **1.7 CLOSEOUT REQUIREMENTS**

- A. Within one month prior to project substantial completion, calibrate all CO2 and specialty gas sensors and generate calibration reports. Turn over all calibration kits to the Owner.
- B. All relative humidity sensors shall not be ordered or installed until the project is within 6 months of substantial completion. If sensors are installed prior to that date, they shall be recalibrated within one month prior to substantial completion.
- C. Provide instructions on how to calibrate all sensors on the project. If a sensor cannot be field recalibrated but has the ability for replacement calibrated parts, include a source for obtaining the replacement parts.
- D. Provide O&M Manual. Refer to 23 0010 for Operation and Maintenance (O&M) and Owner training requirements. Include the following:
  - 1. Manufacturer's catalog data and specifications for all products and devices.
  - 2. A copy of all device calibration reports and certifications (e.g. NIST).
  - 3. Certificate of Demonstration for Owner training on the BAS as specified in section 23 0100.
  - 4. Owner instruction manual to include the following to the Owner's satisfaction:
    - a. Instruction for all operations of the system.
    - b. Instructions on how to calibrate all sensors. If a sensor cannot be field calibrated but has the ability for replacement calibrated parts, include a source for obtaining replacement parts.
    - c. Reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
    - d. Instructions on how to perform programming functions.
    - e. Glossary of terms and common acronyms.
  - 5. A copy of the warranty.
- E. Provide as-built documentation in the same format as the BAS Design Submittal, updated with all revisions and as-built conditions after the system demonstration has been performed. In the BAS graphics, include a link from the BAS to the final as-built documentation. Also include a PDF copy on the operator workstation. Provide a copy of the as-built point-to-point wiring diagrams and final programmed sequence inside each control panel enclosure. Also indicate exact installed locations on the floor plans for the following :
  - 1. All network controllers

2. Pump differential pressure sensors
  3. Fan differential pressor sensors
  4. Outdoor air temperature and/or humidity sensor
- F. Provide a warranty on the entire system, including software, hardware, and labor. Refer to 23 0010 for warranty requirements. Provide an extended five (5) year warranty on all control valves and control valve actuators.
1. In the last month of the warranty period, all BAS software and controller firmware, software, drivers, etc., shall be upgraded and validated to the latest release (version) in effect at the end of the warranty period.
  2. At the end of the warranty period, the final version of all BAS software and programming shall be fully backed up on external storage device(s) (e.g. CD, USB drive, etc.). Include all software licenses. Turn the external storage device over to the Owner.

## **1.8 PRE-PROGRAMMING DESIGN REVIEW MEETING**

- A. Prior to starting programming, a design review meeting shall be scheduled with the Design Professional. The agenda of this meeting will be to discuss the design intent, review all systems requiring control, review naming conventions, and answer any questions the Temperature Controls Contractor may have.

## **1.9 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with requirements, acceptable manufacturers are as follows:
1. Johnson Controls – Madison Branch Office
  2. Schneider Electric – North American Mechanical, Inc.
  3. Automated Logic – Madison Branch Office
  4. Alerton – Masters Building Solutions
  5. Honeywell – Madison Branch Office
  6. Trane Controls – Trane Madison

### **2.2 SYSTEM ARCHITECTURE**

- A. The complete electronic BAS system may be comprised of the following levels of control devices.
1. Operator Workstation includes the hardware and software necessary for an operator to interface with the control system.
  2. Central File Server shall store all data required by the system and be permanently connected to the network.
  3. Network Controller(s) are used for high level global programming functions and system networking.

4. Local Controllers are for control of large primary HVAC systems such as air handling systems, heating hot water systems and chilled water systems.
  5. Application Specific Controllers are dedicated for specific equipment such as VAV boxes, fan coils, and heat pumps.
  6. Repeaters are used for communication signal enhancement along the Tier 2 network.
  7. Gateways are used to allow communication between two different communication protocols.
  8. Network thermostats dedicated to specific equipment such as VAV boxes, fan coils, or heat pumps, etc.
  9. Field devices include, but are not limited to, electronic sensors, valves, actuators, switches, relays, and transducers.
  10. Tier 1 level network is the main backbone of the system and shall be an Ethernet Local Area Network (LAN). All network controllers, the Operator Workstation, and the Central File Server shall be connected directly to this network without the need for gateway devices.
  11. Tier 2 level networks are the communication busses managed by the network controllers. Local Controllers and Application Specific Controllers shall reside on a Tier 2 communication bus without any third-party controllers. All third-party controllers shall reside on a Tier 2 communication bus dedicated to third-party controllers.
- B. Data throughout any level of the network shall be available to and accessible by all other devices, controllers, the Central File Server, and the Operator Workstation.
- C. Interruptions or faults at any point on the network shall not interrupt communications between other nodes on the network.
- D. The BAS network shall support both copper and optical fiber communication media.
- E. All line drivers, repeaters, signal conditioners, etc., shall be provided as necessary for proper data communication.
- F. The system shall use the same application programming language for all levels.
- G. The system shall be configured as a distributed processing network(s) capable and shall be scalable and expandable at all levels of the system using the same software interface and the same types of controllers. Systems that require replacement of either the workstation software or any controllers to expand the system shall not be acceptable.

### **2.3 OPERATOR WORKSTATION**

- A. Provide a desktop computer operator workstation with the following minimum requirements:
1. Processor with a minimum 64-bit structure and minimum 2 GHz processor speed.
  2. Onboard RAM of 4 GB.
  3. Hard drive or equal high-speed data storage with a minimum of 500 GB or as required to meet minimum data storage requirements of the project.
  4. Operating system of Windows 10.
  5. Removable high-speed data storage and export device(s) such as USB (minimum of 2 ports).
  6. Ethernet port.
  7. Full color, flat screen monitor, minimum 24 inches diagonal screen, 16:9 aspect ratio, minimum 1920 x 1080 resolution.
  8. Full ASCII keyboard with wired connection.
  9. Wireless optical mouse.

10. Software and licenses as required to allow for full functionality of the BAS system.
11. Server software or capability as required by project trending and storage requirements.

## **2.4 DATA STORAGE**

### **A. Central File Server:**

- 1.

### **B. Cloud Service:**

- 1.

## **2.5 OPERATOR INTERFACE**

### **A. General:** The BAS operator interface shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the BAS system by authorized users at the Operator Interface.

1. User access to the BAS system shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level (minimum of 4 levels) and partitionable to accommodate the varied access requirements of different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to manage individual user password and access privileges under the control of a master password.
2. The operator interface shall be able to combine data from any and all of the system components in a single browser window. This shall include historical data stored on a server.
3. The operator interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
  - a. User access for selective information retrieval and control command execution.
  - b. Monitoring and reporting.
  - c. Alarm, non-normal, and return to normal condition annunciation.
  - d. Selective operator override and other control actions.
  - e. Information archiving, manipulation, formatting, display and reporting.
  - f. BAS internal performance supervision and diagnostics.
  - g. On-line access to user HELP menus.
  - h. On-line access to current BAS as-built records and documentation.
  - i. Means for the controlled re-programming, re-configuration of BAS operation and for the manipulation of BAS database information in compliance with the prevailing codes, approvals and regulations for individual BAS applications.
4. Provide BAS reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations and the like to assist user understanding and interpretation.
5. All text naming conventions shall be consistent in their use and application throughout the BAS and coordinated with Owner preference.

B. Web Interface

1. The system shall be capable of supporting clients using a standard web browser such as Internet Explorer™. Systems requiring additional software (to enable a standard Web browser) are not acceptable.
2. The web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the graphical user interface on the operator workstation. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be acceptable.
3. The web browser client shall support at a minimum, the following functions:
  - a. User log-on identification and password shall be required. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
  - b. Users shall have administrator-defined access privileges.
  - c. The system shall provide the capability to specify a users home page. Provide the ability to limit a specific user to just their defined home page. From the home page links to other views, or pages in the system, shall be possible if allowed by the system administrator.
  - d. Graphical screens developed for the operator interface shall be the same screens used for the web browser client. Any animated graphical objects supported by the operator workstation software shall be supported by the web browser interface.
  - e. HTML programming shall not be required to display system graphics or data on a web page. HTML editing of the web page shall be allowed if the user desires a specific look or format.
  - f. Real-time values displayed on a web page shall update automatically without requiring a manual “refresh” of the web page.
  - g. Graphic screens on the web browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

C. Alarms: Alarms shall be routed directly from network controllers to the operator workstation and/or servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the operator interface software shall, at the minimum, provide the following functions:

1. The BAS shall annunciate diagnostic alarms, at a minimum, indicating system failure, individual controller failure, individual component failure, and non-normal operating conditions.
2. Any attribute of any object in the system may be designated to report an alarm.
3. Log date and time of alarm occurrence.
4. Generate a “pop-up” window, with audible alarm, informing a user that an alarm has been received.
5. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
6. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
7. Provide the ability to direct alarms to an e-mail address or phone number via text message. This must be provided in addition to the pop up window described above. Systems which use e-mail and/or text messaging as the exclusive means of annunciating alarms are not acceptable.

- D. Reports: Reports shall be generated and directed to one or more of the following: operator interface displays or an archive at the user's option. As a minimum, the system shall provide the following reports:
1. All points in the BAS system.
  2. All points in each BAS application.
  3. All points locked out or overridden in a BAS application.
  4. All points currently in alarm in a BAS application.
  5. All BAS schedules.
  6. All user defined and adjustable variables, schedules, interlocks, etc.
  7. BAS diagnostic and system status reports.
- E. Navigation Tree: The system shall have an intuitive and easy to navigate collapsible and expandable navigation tree. Requirements of the navigation tree shall include:
1. A dedicated folder where links to all graphics are located. In systems with many different graphics, locate similar equipment graphics in a sub-folder (e.g. VAVs for Level 1 in a sub-folder).
  2. A grouping of all systems/equipment/points by the network controller and communication bus it resides on. All systems and equipment shall match the names indicated on the plans.
  3. A minimum of 5 collapsible and expandable levels.
  4. Links to long-term trends.
  5. Links to all alarms and alarm history logs.
  6. Ability for the operator to customize the navigation tree by defining groupings and adding any systems or points to those groups and modifying the order of groups.
  7. Ability for groups to be located within other groups.
  8. Ability to rename any group, system, or point in the navigation tree.
- F. Dynamic Color Graphics: The system shall allow for the creation of user defined, color graphic displays for the viewing of HVAC, systems, electrical systems, building schematics, etc. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, users with the appropriate security level shall be able to command equipment or change setpoints from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:
1. An unlimited number of graphic displays shall be able to be generated and executed.
  2. Graphics shall be based on vectorized technology and HTML5 programming language. Rasterized graphics and Java programming language are not acceptable.
  3. Values of real time attributes displayed on the graphics shall be dynamic and updated on the displays.
  4. The graphic displays shall be able to display and provide animation based on real-time BAS data that is acquired, derived, or entered.
  5. Users with the appropriate security level shall be able to change values (setpoints) and states in system controlled equipment directly from the graphic display.
  6. Provide a graphic editing tool that allows users with the appropriate security level to create and edit graphic files. It shall be possible to edit the graphics directly while they are on line, or at an off line location for later downloading to the controller.
  7. BAS system shall be provided with a complete user expandable symbol library containing all of the basic symbols used to represent typical system components. Implementing these symbols in a graphic shall involve dragging and dropping them from the library to the graphic.

8. The following graphics, at a minimum, shall be provided:
  - a. Floor plan graphics showing all as constructed room numbers, zoning boundaries, zone level space sensors readings (temperature, relative humidity, occupancy, CO<sub>2</sub>, CO, etc.) and indicate accurate locations of the sensors. The floor plan graphics shall also show the as constructed location and name of all network controllers.
    - 1) All readings shall be color coded to indicate the deviation from current set point and a legend describing the colors and associated deviation scale.
    - 2) Any readings in an alarm shall flash on the graphic.
    - 3) All zones shall include a link to the zone level equipment graphic page.
  - b. Central system graphics showing all equipment and components with interconnecting piping/ductwork in schematic form. Equipment and components shall be accurately placed relative to each other on the schematic.
    - 1) Each hydronic piping system.
    - 2) Each air handling system.
  - c. A graphic screen for all equipment connected to the BAS system. At a minimum, all points listed in the minimum points list on the plans shall be visible on the graphic screen.
    - 1) Include a separate graphic screen for every individual piece of equipment. Where two or more pieces of equipment are redundant (e.g. system pumps), they may reside on the same graphic screen.
    - 2) Where a reset or staging schedule is required, include the details of the reset schedule and staging schedule on the graphics. Indicate the current set point or stage as calculated by the reset or staging schedule.
    - 3) Where a software button is required by the sequence, include the software button on the graphic.
    - 4) All software points listed on the plans shall also be included on the graphic.
  - d. Where redundant equipment is set up as lead/lag, the graphic screen shall include the ability for the user to switch the lead/lag positions.
- G. Schedules: It shall be possible to configure and download all schedules within the BAS from the operator interface.
  1. The system shall provide multiple schedule input forms for automatic BAS time-of-day scheduling and override scheduling of BAS operations. At a minimum, the following spreadsheet types shall be accommodated:
    - a. Weekly schedules.
    - b. Monthly schedules.
    - c. Special “Only active if today is a holiday” schedules.
    - d. Temporary override schedules.
  2. Schedules shall be provided for each individual piece of equipment. Similar equipment on the same system shall also be able to be scheduled globally. For example, All VAVs on an AHU system shall be able to have the same schedule as the AHU or their own individual schedule for each VAV. Each schedule shall include all output points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.
  3. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

- H. Power failure and automatic restart:
1. Provide for the automatic, orderly and predefined shutdown of parts or all of the BAS following total loss of power to parts or all of the BAS.
  2. Provide for the automatic, orderly and predefined startup and return to normal control of parts or all of the BAS following total loss of power to those parts or all of the BAS. Archive and annunciate time and details of restoration.
  3. Maintain the operation of the BAS real-time clock during periods of power outage for a minimum of 72 hours.
- I. Historical trending and data collection: Trend and store point data as indicated on the plans. Long-term data collection can be stored locally if memory allows or offloaded to a separate system server or hard drive. Data shall be capable of being exported in a .csv, .xls or .xlsx format or other acceptable formats for custom queries and reports using industry standard software analysis tools.
1. Trend shall be capable of recording as raw data or data that is filtered where specified to be filtered before recording by the following typical filter types:
    - a. Average value.
    - b. Maximum value.
    - c. Minimum value.
    - d. Change of value (COV).
    - e. Change of state (COS).
    - f. Range – difference between minimum and maximum values.
  2. The software shall be able to perform the following functions on a set of user selected data:
    - a. Standard deviation.
    - b. Sum of all values.
    - c. Variance.
  3. Trends shall be able to be displayed in a table or graphical format. Trends shall be able to be saved in the navigation tree for future reference. The graphical display shall have the following capabilities:
    - a. Displaying multiple trends of any user selected points on one graph.
    - b. Adjust both the x-axis and y-axis scales.
    - c. Utilize multiple y-axes with unique scales and assign trends to either axis at the user's choosing.
    - d. Change trend colors, line types, and line weights.
    - e. Change display of trends between analog values and binary. Binary displays shall have the option to be displayed as a square wave.
- J. Point naming conventions and abbreviations shall be consistent with the plans and be consistent between all systems and equipment.

## 2.6 NETWORK CONTROLLERS

- A. General: The network controller shall be a microprocessor based, multi-tasking real time system controller that provides advanced system programming, uplink and downlink communications, polling and other supervisory functions for local and application specific controllers.
- B. Each network controller shall be classified as a BACnet compatible device, supporting the BACnet Building Controller (B-BC) profile. Controllers that support a lesser profile such as B-AAC, B-ASC, or B-SA are not acceptable. Network controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-BC).



### C. Hardware Specifications

1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.
2. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory. If the controller does not have the required built-in memory capacity, a separate data storage device shall be provided.
3. Communication Ports: Each network controller shall provide communication to both the Operator Workstation(s) and the field buses. An on-board Ethernet port shall be provided.
4. Stand-Alone: The controller shall be a true no-host system that does not require a PC or "Host" computer to perform any control functions or communications.
5. Modular Expandability: The system shall employ a modular input/output (I/O) design to allow easy expansion. Input and output capacity is to be provided through plug-in modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
6. Real Time Clock (RTC): Each network controller shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day of week, day, month, and year. The system shall automatically correct for daylight savings time and leap years.
7. Power Supply: The power supply for the network controller shall be auto sensing, 120 VAC, 60 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered a power outage. The controller shall contain over voltage surge protection and require no external AC power signal conditioning.
  - a. Automatic Restart After Power Failure: Upon restoration of power after an outage, the network controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
  - b. Battery backup: The network controller shall include an on-board battery to back up the controller's RAM. The battery shall have a shelf life of over 5 years and provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the network controller shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the network controller shall restart itself from its application program stored in its FLASH memory.
8. Field communication ports shall be individually electrically isolated to protect against transients, spikes, and power surges. The ports shall be optically isolated from each other, the controller circuit board and from power wiring. Optical isolation shall be provided either as an integral component to the controller or provided as a separate interface device between the controller and field wiring.
9. Failure of any network controller shall register as an alarm in the BAS.

### D. Network Controller Software

1. General: The network controller shall contain FLASH memory to store both the resident operating system and the application software. There will be no restrictions placed on the type of application programs in the system. Each network controller shall be capable of parallel processing and executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

2. Passwords: User access to the controller shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level (minimum of 4 levels) and partitionable to accommodate the varied access requirements of different user groups. Provide the means to define unique access privileges for each individual authorized user. Also provide the means to establish general password groups to which an individual will then be assigned. Once assigned to the group each individual will assume all the capabilities and restrictions of that group. Provide the means to manage individual user password and access privileges under the control of a master password.
3. Login: A user definable login message shall be displayed every time the workstation is connected to a system controller.
4. User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings. Controllers that use a "canned" program method will not be accepted.
5. Help Menu: On-line location sensitive help shall be provided for each menu item, describing the consequences of making the highlighted menu selection.
6. Programming Functions: The software blocks shall provide all the necessary mathematics, logic, utility, and control functions necessary for proper sequence of control. These functions shall be contained in the network controller operating system to be available in any combination for field programming the unit through RAM memory.
  - a. Proportional, Integral plus Derivative Control (PID)
  - b. Self-tuning PID
  - c. Two position control
  - d. Digital filter
  - e. Ratio calculator
  - f. Equipment cycling protection
7. Energy Management Applications: As a minimum, the network controller shall have the ability to, but not be limited to, perform energy management strategies such as:
  - a. Time or event based scheduling
  - b. Calendar/holiday based scheduling
  - c. Temporary schedule overrides
  - d. Adaptive optimum start/stop
  - e. Chiller and boiler reset/optimization
  - f. Demand limiting/load shedding
  - g. Enthalpy switchover (economizer)
  - h. Temperature compensated duty cycling
  - i. CFM tracking
  - j. Temperature or pressure reset
  - k. Run time totalization
  - l. Alarm detection and dial out or email out
  - m. Night setback
  - n. Historical trending

8. Alarms: The network controller shall be capable of comparing analog and digital readings to predetermined high and low limits and annunciate each time a value enters or returns from an alarm condition. Unique high and low limits shall be supplied for each analog point in the network. The network shall be capable of suppressing selected alarm reporting when the primary equipment from which the alarm point is based is in the inactive state. The alarm features of the system controller software shall, as a minimum, provide the following:
  - a. Digital, analog, and hi/low settings and deadband
  - b. Sliding alarm limits
  - c. Conditional alarming
  - d. Alarm inhibiting through feedback loop
  - e. Fluttering alarm suppression
  - f. Separate tailored alarm messages of 70 characters each
  - g. Auto dial of any user selected alarm condition to a minimum of 25 telephone numbers
  - h. Auto email of any user selected alarm condition to a minimum of 25 email addresses
9. Trending: Each network controller shall have the capability to simultaneously trend a minimum of 60 combined points. Adjustable sampling intervals for each trend from 30 seconds to one day or on change of value/state shall be possible. Each trend shall be capable of being automatically started or stopped, based on time of day, externally sensed points, alarms, or a calculated value. Upload of trend data to the operator workstation or other memory storage device shall be automatically performed at any time during the sampling period. The uploaded trend data shall be fully compatible with Microsoft Excel.
10. On-Line Testing: The network shall have the capability to allow the operator to design, test, and implement desired control strategies on-line.
11. Communication Diagnostics: The network controller software shall be capable of self-diagnosing failure automatically without necessary query by the operator. In the event of communications failure or limited power failure, the network shall be capable of both notifying a local operator of the specific occurrence, as well as communicating to a remote operator, either by the internet or auto dialing/emailing the condition. In addition to automatic self-diagnostics, each network controller shall maintain communications statistics on local and application specific controller communications. These statistics shall tabulate total communications attempted versus successful and unsuccessful communications by unit number. An option shall exist to reset communications statistics to zero (0) at any time.

## 2.7 LOCAL CONTROLLERS

- A. General: Each HVAC local controller shall be a stand-alone BAS controller. The local controllers shall be a local control loop microprocessor-based controller installed at each HVAC system (e.g. air handling unit, heating plant, chilled water plant). Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated network controller.
- B. Each local controller provided must be a BACnet device, supporting the BACnet Advanced Application Controller (B-AAC) profile. Controllers that support a lesser profile such as B-ASC or B-SA are not acceptable. Local controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controller(B-AAC).
- C. Hardware:
  1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.

2. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application plus required history logging. All controllers with volatile memory shall have a battery-backup for a minimum of 72 hours. Each controller shall be addressable by a workstation or laptop.
  3. Isolation: Control, communication, and power circuits for each controller shall be individually electrically isolated to protect against transients, spikes, and power surges.
  4. Input/Output Modules: Provide with at least the minimum quantity of inputs and outputs as required by the sequence of operations and points list.
    - a. Analog inputs shall accept industry standard analog signals (4-20 mA, 0-5 VDC, 0-10 VDC, etc.).
    - b. Binary inputs shall detect contact closures.
    - c. Universal inputs shall have functionality as either an analog or binary input.
    - d. Digital outputs may be latched or momentary contact type.
    - e. Analog outputs shall have a 1% resolution over total output span of 100%.
    - f. Configurable outputs shall have functionality as either an analog or binary output.
  5. Expandability: Provide input and output expansion capability through the use of plug-in modules. At least two I/O expansion modules must be capable of being added to the base local controller.
- D. Software: Provide complete controller software to execute all HVAC system local loop controls functions.
1. Control Parameters: The software blocks in the local controller shall produce all of the necessary reverse acting and/or direct acting PI signals as required by the control sequence. The proportional and integral values which make up the PI output value shall be readable and modifiable, at the system workstation or the portable service tool to facilitate tuning of control loops.
  2. Networking: Each input, output, or calculation result shall be capable of being assigned to the system controller for system networking. The local controller shall also provide the ability to download and upload configuration data, both locally at the controller and via the BAS communications network.
  3. Scan: Controller shall continuously scan and maintain the most recent data in RAM for retrieval by a network controller, operator interface, and by the local controller software programs.
  4. Database: All field control databases shall be entered, changed or downloaded to the local controllers via a laptop or operator workstation.
  5. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.
  6. Memory: Provide amount of memory required to store data until it is sent to the network controller.
  7. Programming Functions: Provide the following standard BAS loop programming functions:
    - a. Control block programming
    - b. PI or PID control
    - c. Serial load staging
    - d. Binary load staging
    - e. Analog load staging
    - f. Master-submaster routines
    - g. Anti-windup for integrated loops

8. Real Time Clock (RTC): All local controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each local controller shall receive a signal, every hour, over the network from the network controller, which synchronizes all local controllers' real time clocks.

E. Failure Operation:

1. Automatic Restart After Power Failure: Upon restoration of power after an outage, the controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
2. Stand-Alone Operation During Network Communication Failure: Controllers requiring the application or database to be downloaded from a host or share processing with a network controller shall not be acceptable. During a communication failure the application specific controller must run the control application using the current setpoints and configuration.
3. Failure of any local controller shall register as an alarm in the BAS.

## 2.8 APPLICATION SPECIFIC CONTROLLERS

- A. General: Each HVAC application specific controller shall be a stand-alone BAS controller. The controller shall include all hardware and software required for communications with the network controller. Unless noted otherwise, an individual application specific controller shall be dedicated for each terminal device.
- B. Each application specific controller provided must be a BACnet device, supporting the BACnet Application Specific Controller (B-ASC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. Local controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Application Specific Controllers (B-ASC).
- C. Hardware:
  1. Operating Environment: The controller shall be capable of operating in an environment of 32 to 122 deg F and 10 to 90% relative humidity non-condensing.
  2. Input/Output Modules: Provide with at least the minimum quantity of inputs and outputs as required by the sequence of operations and points list.
    - a. Analog inputs shall accept industry standard analog signals (4-20 mA, 0-5 VDC, 0-10 VDC, etc.).
    - b. Binary inputs shall detect contact closures.
    - c. Universal inputs shall have functionality as either an analog or binary input.
    - d. Digital outputs may be latched or momentary contact type.
    - e. Analog outputs shall have a 1% resolution over total output span of 100%.
    - f. Configurable outputs shall have functionality as either an analog or binary output.
  3. Expandability: Provide input and output expansion capability through the use of plug-in modules. Where additional inputs or outputs are required for the specified application, provide the expansion module with the application specific controller.

D. Software:

1. Programming: The control program shall reside in the application specific controller. The application program shall be maintained in read only memory (ROM). The default database, i.e. setpoints and configuration information, shall be stored in electrically erasable programmable read-only memory (EEPROM). Controllers requiring local setting of potentiometers or dip switches are not acceptable for programming functions. Dip switches for creating unique addresses for controllers are acceptable.
2. Auto-Calibration: All inputs shall feature an auto-calibrate function to eliminate sensing errors.

E. Failure Operation:

1. Automatic Restart After Power Failure: Upon restoration of power after an outage, the controller shall automatically and without human intervention: update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
2. Stand-Alone Operation During Network Communication Failure: Controllers requiring the application or database to be downloaded from a host or share processing with a network controller shall not be acceptable. During a communication failure the application specific controller must run the control application using the current setpoints and configuration.
3. Failure of any application specific controller shall register as an alarm in the BAS.

## 2.9 REPEATERS AND SIGNAL CONDITIONERS

- A. Provide a repeaters and signal conditioners at locations in the controls network where required.

## 2.10 GATEWAYS

- A. Provide a gateway at all points of connections of dissimilar controls networks/protocols. The gateway shall permit the exchange of all specified and required information between the two dissimilar networks/protocols.

## 2.11 FIELD DEVICES

A. Multi-Purpose Sensors:

1. All multi-purpose or combination sensors shall meet all requirements listed below for the individual sensors that are being combined into one unit.
2. Sensors are only allowed to be combined if shown in the exact same location on the controls schematics, HVAC plans, or elevations with no components between them.

B. Temperature Sensors:

1. General:
  - a. All temperature devices shall use precision thermistors or RTD sensors accurate to +/- 1 degree F over a range of -30 to 230 degrees F, unless indicated otherwise.
2. Space Sensors and/or Thermostats:
  - a. Sensors shall be available in an off-white ventilated enclosure, unless noted otherwise on the plans. Sensor shall be able to be mounted on a standard electrical box.

- b. Where indicated on the plans, the sensor housing shall feature both a mechanism for adjusting the space temperature set point and/or a push button for selecting after hours occupied operation.
  - c. Where indicated on the plans, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, set point, and other operator selectable parameters. Using built in buttons, operators shall be able to adjust set points directly from the sensor. Resolution shall be as indicated on the plans.
  - d. Minimum sensing range shall be 32 to 100 deg. If a space is being controlled to a set point outside of this range, then a sensor appropriate for the application shall be provided.
  - e. All sensors shall be the same appearance in the occupied and public areas of the building, but may have different options as required (set point adjustment, override button, etc.). Exceptions that would allow a different appearance include mechanical rooms, electrical rooms, storage rooms, vestibules, etc.
3. Duct Sensors: Sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Wiring shall terminate in a galvanized steel box at the end of the probe, except where wiring factory provided wiring can be connected to a controller without additional wiring. Probe style duct sensors are required in air handling applications where the coil or duct area is less than 14 square feet.
    - a. For duct widths 12" or less, use a minimum 4" probe.
    - b. For duct widths between 13" and 24", use a minimum 8" probe.
    - c. For duct widths larger than 24", use a minimum 12" probe.
  4. Averaging Temperature Sensors: Sensors shall be employed in ducts which are larger than 14 square feet. The length of flexible copper tubing shall cover no more than one square foot of face area per one linear foot of sensing element length. The maximum length of the copper tube for one device shall be 24 ft. Where a longer length is required, multiple sensors shall be provided and the average temperature calculated by software programming.
  5. Immersion Sensors: Sensors shall be employed for measurement of temperature in all hydronic, domestic water, and refrigerant piping applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Wiring shall terminate in a galvanized steel box at the end of the probe. The length of the probe shall extend into the pipe so the end of the probe is in the middle third of the pipe. Use for all water temperature sensors on all pipe sizes 2" and larger, unless indicated otherwise on the controls schematics.
  6. Pipe Surface Mount Temperature Sensors (Strap-on): Use on all pipe sizes 1-1/2" and smaller or where specifically indicated on the controls schematics.
  7. Freezestats: Low limit temperature sensors with manual reset and capillary tube that senses the lowest temperature along the length of the capillary. The length of the capillary tube shall cover no more than one square foot of face area per one linear foot of capillary tube length. Where long lengths are required, provide multiple freezestats. The sensor shall be adjustable throughout the entire temperature range of 15 to 55 deg F.
  8. Outdoor Air Sensors: Provide with weather shield to protect against solar radiation and precipitation with multiple discs/shields over the probe to allow for good airflow and accurate readings even if mounted in direct sunlight. Minimum sensing range shall be from -40 to 140 deg F.
  9. Slab Sensors: Sensor shall accurately measure temperatures below 40 deg F. Provide with an enclosure to be recessed into the slab.

C. Humidity Sensors:

1. Space Sensors:
  - a. Humidity sensors shall be of the solid-state type using a hygroscopic polymer or thin film capacitive sensing element.
  - b. Sensors shall be available in an off-white ventilated enclosure, unless noted otherwise on the plans. Sensor shall be able to be mounted on a standard electrical box.
  - c. Accuracy: +/- 3% over a range of 0-90% non-condensing.
  - d. Accuracy: +/- 1% over a range of 0-90% non-condensing. Sensor shall have a multi-point calibration and be NIST certified.
  - e. Stability: +/- 1% annually over 2 years.
2. Duct and/or Air Moving Equipment Sensors:
  - a. Humidity sensors shall be of the solid-state type using a hygroscopic polymer or thin film capacitive sensing element.
  - b. Accuracy: +/- 3% over a range of 0-90% non-condensing.
  - c. Accuracy: +/- 1% over a range of 0-90% non-condensing. Sensor shall have a multi-point calibration and be NIST certified.
  - d. Stability: +/- 1% annually over 2 years.
  - e. Where installed in high velocity ductwork, provide an element guard.
3. Outdoor Air Sensors:
  - a. Provide with weather shield to protect against solar radiation and precipitation with multiple discs/shields over probe to allow for good airflow and accurate readings even if mounted in direct sunlight.
  - b. Accuracy: +/- 2% over a range of 0-90% non-condensing.
  - c. Stability: +/- 1% annually.
4. All humidity sensors shall be able to be recalibrated in the field or the sensing tip to be replaced without replacing the entire sensor.

D. Carbon Dioxide (CO<sub>2</sub>) Sensors:

1. Sensing Technology: Non-Dispersive Infra-Red (NDSR) with single lamp, dual wavelength.
2. Range: 0 – 2,000 ppm or 0 – 5,000 ppm as required based on the control and alarm concentrations indicated on the plans. If no concentrations are indicated, use 0 – 2,000 ppm.
3. Accuracy: +/- 2% of range or 2% of reading.
4. Stability: +/- 5% over 5 years.
5. Provide with one CO<sub>2</sub> calibration kit for the entire project. Kit shall include two 17-liter CO<sub>2</sub> calibration gas cylinders, one at 200 ppm and one at 1,000 ppm. Also provide a gas regulator, tubing, fittings, adapters, sensor cones, etc., as required for the application.

E. Specialty Gas Detection:

1. All specialty gas detection components shall be manufactured by one of the following:
  - a. Critical Environment Technologies
  - b. Honeywell
  - c. QEL (Quatrosense Environmental Ltd)
2. Carbon Monoxide (CO) Sensors:
  - a. CO sensors shall be UL 2075 listed



- b. Sensing Technology: Electrochemical.
  - c. Range: 0 – 200 ppm.
  - d. Stability: +/- 3% per year.
  - e. Detection Range: 50 ft radius.
  - f. Enclosure: Waterproof with hinged door, LED display, audible alarm, and silence button.
  - g. Provide with one CO calibration kit for the entire project. Kit shall include two CO calibration gas cylinders, each at different concentrations within the sensor range. Also provide a gas regulator, tubing, fittings, adapters, sensor cones, etc., as required for the application.
3. Nitrogen Dioxide (NO<sub>2</sub>) Sensors:
- a. Sensing Technology: Electrochemical.
  - b. Range: 0 – 10 ppm.
  - c. Stability: +/- 2% per month.
  - d. Detection Range: 50 ft radius.
  - e. Enclosure: Waterproof with hinged door, LED display, audible alarm, and silence button.
  - f. Provide with one NO<sub>2</sub> calibration kit for the entire project. Kit shall include two NO<sub>2</sub> calibration gas cylinders, each at different concentrations within the sensor range. Also provide a gas regulator, tubing, fittings, adapters, sensor cones, etc., as required for the application.
4. Specialty Gas Central Controller:
- a. Enclosure: Waterproof with hinged door, LED display, audible alarm, and silence button.
  - b. Provide with multi-channel inputs (4-20 mA or 0-10 VDC) compatible with the sensors/transmitters provided. Provide the quantity of controllers as required based on the number of sensors/transmitters. Link controllers together if multiple controllers are required.

F. Refrigerant Monitoring and Detection:

- 1. All specialty gas detection components shall be manufactured by one of the following:
  - a. Critical Environment Technologies
  - b. Honeywell
- 2. Refrigerant Sensors:
  - a. Refrigerant: R134a
  - b. Sensing Technology: Infrared sensor.
  - c. Range: 0 – 1,000 ppm.
  - d. Resolution: 1 ppm
  - e. Accuracy: +/- 40 ppm at 500 ppm.
  - f. Provide with one refrigerant calibration kit for each type of refrigerant on the entire project. Kit shall include two refrigerant cylinders, each at different concentrations within the sensor range. Also provide a gas regulator, tubing, fittings, adapters, sensor cones, etc., as required for the application.
- 3. Refrigerant Monitoring and Detection Central Controller:
  - a. Enclosure: ABS with LCD or LED display, audible and visible alarm, malfunction and diagnostic warning features.

- b. Provide with multi-channel inputs (4-20 mA or 0-10 VDC) compatible with the sensors/transmitters provided. Provide the quantity of controllers as required based on the number of sensors/transmitters. Link controllers together if multiple controllers are required.
  - 4. Refrigerant Monitoring and Detection Remote Controller:
    - a. Enclosure: ABS with LCD or LED display.
    - b. Provide with multi-channel inputs (4-20 mA or 0-10 VDC) compatible with the sensors/central controllers provided. Provide the quantity of controllers as required based on the number of sensors/transmitters. Link controllers together if multiple controllers are required.
- G. Differential Pressure Sensor: Differential pressure sensor shall be temperature compensated and shall vary the output voltage with a change in differential pressure. Sensor shall have a non-repeatability of +/- 0.05% of range. Sensor shall be capable of withstanding up to 150% of rated pressure without damage.
  - 1. Duct differential pressure sensors shall have an appropriate range for the application with a minimum accuracy of +/- 1% of range.
    - a. Sensors in positively pressurized ductwork (typically downstream of the supply fan) shall only have a positive range.
    - b. Sensors in negatively pressurized ductwork (typically upstream of a fan) or between fans in series (typically in an air handling unit) shall have both a negative and positive range.
  - 2. Room differential pressure sensors shall have a range of -0.25" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range.
  - 3. Underfloor plenum differential pressure sensors shall have a range of 0" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range.
  - 4. Building differential pressure sensors shall have a range of -0.25" w.c. to 0.25" w.c. and a minimum accuracy of +/- 0.5% of range. Sensor shall be provided with a pressure sensing tip that incorporates a shield to minimize the effect of wind.
  - 5. Water differential pressure sensors shall be accurate to +/- 0.5% of range. The housing shall be NEMA 4 rated.
  - 6. Steam and gas differential pressure sensors shall be accurate to +/- 0.5% of range. The housing shall be NEMA 4 rated.
- H. Air Differential Pressure Switches: Differential pressure switches shall be field adjustable with a range appropriate for the duct pressure classification and include manual reset. The switch shall be capable of withstanding up to 150% of rated pressure without damage. Provide a red pilot lighted reset button located on the control panel that is wired to the manual reset from the switch.
  - 1. Fan Inlet Air Flow Measuring Stations:
    - a. Airflow measuring stations to be Ebtron Gold Series GTx108-F. The number of independent sensor nodes provided shall be as follows:
      - 1) SWSI and DWDI fans: 2 probes x 1 sensor node/per probe in each fan inlet.
      - 2) Fan Arrays (2 to 4 fans): 2 probes x 1 sensor node per probe in each fan inlet.
      - 3) Fan Arrays (5 to 8 fans): 1 probe x 1 sensor node per probe in each fan inlet.
    - b. Each sensing node shall independently determine the airflow rate, which shall be equally weighted in calculations by the transmitter prior to output as the average for the duct and be linear to flow.
    - c. Each device shall have a certified accuracy of +/-2% of reading over the entire calibrated airflow range of 0 to 10,000 fpm, including repeatability of 0.25% of reading.

- d. Analog output resolution shall be equal to or better than 0.025% full-scale.
- e. Each device shall be individually wind tunnel calibrated as an assembly to volumetric airflow standards. The design shall include compensation for flow losses to eliminate inaccuracies associated with airflow measurement in small ducts.
- f. Required Environmental Operating Range
  - 1) The transmitter operating temperature range shall be at least -20° F to 120° F.
  - 2) The sensor probe operating temperature range shall be at least -20° F to 160° F.
  - 3) The operating humidity range shall be at least 0 to 99% (non-condensing).
- g. Each sensor probe shall consist of one sensor node mounted on a 304 stainless steel block with two adjustable zinc plated steel rods connected to 304 stainless steel pivoting mounting feet.
- h. The transmitter shall be capable of field configuration and diagnostics and identifying a faulty sensor node, ignore it and continue to operate by correctly averaging the remaining sensor node.
- i. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.
- j. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.

I. Water Flow Measuring Stations (WFMSs):

- 1. General:
  - a. All WFMSs shall be manufactured by Onicon.
- 2. Inline Electromagnetic Flow Meter:
  - a. Provide model F-3200.
  - b. The flow station shall operate at +/- 0.2% of reading from 1.6 to 33 ft/s of and +/- 0.0033 ft/s from 0.033 to 1.6 ft/s.
  - c. Provide meter liner of appropriate material based on the application. All heating hot water flow meters shall have a PTFE liner.
  - d. Provide with remote mounted display enclosure for mounting below 7 ft in the mechanical room.

J. BTU Meters:

- 1. All BTU meters shall be manufactured by Onicon and be paired with an Onicon flow meter and Onicon temperature sensors. All components shall come as a packaged, calibrated system.
- 2. Provide model System-10 BTU meter with display.
- 3. Provide with a BACnet communication protocol.

K. Control Valves:

- 1. General:
  - a. Globe Valves shall have renewable composition discs a recommended by manufacturer for the intended service or renewable bevel seats and metal discs. Valves on steam service 4" and larger shall have ½" minimum by-pass valve and piping.

- b. Ball Valves 2-1/2" and smaller shall be full port brass two-piece with stainless steel ball, Teflon seats and stuffing box ring with vinyl insulated lever handle. Grooved option shall be ductile iron body with stainless steel ball and stem with TFE seats and fluoroelastomer seals.
  - c. Butterfly valves 2-1/2" and larger shall be ASTM A536 ductile iron body with aluminum bronze disc, EPDM or BUNA N seat, 416 stainless stem with gear box operator and extended neck. Grooved Option shall be black enamel coated ductile iron body conforming to ASTM A536 with nickel plated ductile iron disc with blowout proof 416 stainless steel stem and EPDM seat,
  - d. Valves shall be packless and electrically actuated with true linear flow characteristics in relationship to valve opening.
  - e. Valves shall meet the heating and cooling flow rates specified and close off against the differential pressure conditions for the system in which it is installed.
  - f. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.
2. Hydronic Systems:
- a. Valves with a modulating actuator shall be sized for a 3 to 5 psi pressure drop at the design flow rate.
  - b. Valve shall be 2-way or 3-way as indicated on the plans. If there is no indication, the valve shall be 2-way.
  - c. Pressure Independent Control Valves:
    - 1) The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations.
    - 2) The rangeability of the control valve shall be a minimum of 100 to 1.
    - 3) Each valve shall be provided with p/t ports on the inlet and outlet of the valve.
    - 4) A flow tag shall be provided with each valve.

L. Valve Actuators:

- 1. Actuators shall be electronic and shall be direct coupled over the shaft, without the need for connecting linkage.
- 2. Actuator shall have electronic overload circuitry to prevent damage.
- 3. Actuators shall be available with spring return to the normal position when required or as indicated on the plans.
- 4. Actuators shall have a position indicator for external indication of valve position.
- 5. Actuators shall have manual override capability.
- 6. Actuators shall be quick opening or slow opening as required by the application.
- 7. Actuators shall be able to completely close the valve against system pressure.
- 8. Actuators shall be two-position or modulating as required by the sequence of operations.
- 9. Actuators shall be compatible with the type of valve as indicated on the plans or elsewhere in the specifications (e.g. two-way vs. three-way, ball vs. butterfly, etc.).

M. Control Dampers:

- 1. Damper frames are to be constructed of minimum 13 gauge metal with linkage concealed in the side channel. Provide with compressible spring stainless steel side seals and self-lubricating bearings.
- 2. Damper blade width shall not exceed 8 inches and the blade length shall not exceed 48 inches. Damper blades shall have an airfoil profile to minimize pressure drop through the damper. Seals shall be butyl-rubber or EPDM and are required at the ends of the blades.
- 3. Provide opposed blade dampers for modulating applications and parallel blade for two-position control.

4. Damper shall be constructed of the same material as the duct in which it will be installed, except as noted below:
    - a. Dampers in exhaust or outdoor air ducts shall be aluminum
  5. Dampers in exhaust or outdoor air ducts shall have insulated blades and completely thermally broken construction.
  6. Where damper shafts penetrate the damper housing, it shall be sealed while allowing the free movement of the shaft without breaking the seal.
  7. Damper shall be ultra-low leakage rated as Class 1A at 1" w.c. and Class 1 at 4" w.c. as defined by AMCA 500.
  8. Dampers that are indicated to close completely by the sequence of operations shall be provided with flanged connections.
- N. Damper Actuators:
1. Actuators shall be electronic and shall be direct coupled over the shaft, without the need for connecting linkage.
  2. Actuators shall have electronic overload circuitry to prevent damage.
  3. Actuators shall be available with spring return to the normal position when required or as indicated on the plans.
  4. Actuators shall have a position indicator for external indication of damper position.
  5. Actuators shall have manual override capability without disconnecting damper linkage.
  6. Actuators shall be quick opening or slow opening as required by the application.
  7. Actuators shall be able to completely close the damper against system pressure.
  8. Actuators shall be two-position or modulating as required by the sequence of operations.
  9. Provide the appropriate quantity of damper actuators as required by the application.
- O. Position Switches: Provide switch that can sense the full closed position and an adjustable open position between 10 and 100%.
- P. Current Switches: Current status switches shall be used to monitor motors and other electrical loads as indicated on the plans. Current switches shall be available in solid and split core models and offer either a digital or an analog signal to the automation system. The sensing range of the sensor shall be appropriate for the device being monitored.
- Q. Audible and Visible Alarms: Horn shall be continuous tone with solid-state electric signal and red LED pilot light. Provide a separate silence button (refer to manual push buttons below) to be mounted at an accessible height. The light shall remain on and the alarm condition active even after the silence button is pressed until the alarm state is resolved.
- R. Pilot Lights: Light shall be LED type with push-to-test function and have an oil-tight enclosure. The light shall be green when indicating normal operation and red when indicating an issue or alarm.
- S. Manual Push Buttons: Button shall be round, approximately 3/4" in diameter. Provide with the quantity and type of contacts required for the application. Submit color options for selection by the Design Professional during submittal review.
- T. Manual Switches: Provide line-voltage toggle switch appropriate for the application. Refer to Division 26.

## **2.12 CONTROL WIRING**

- A. The term "control wiring" is defined to include providing of wire, conduit, junction boxes, and miscellaneous materials as required for mounting and connecting electric or electronic control devices and network communication devices.
- B. All control wiring and wiring connections required for the installation of the BAS system shall be provided by BAS Contractor unless specifically shown on the electrical or telecommunication drawings or called for in Division 26 or Division 27.
- C. All control wiring shall comply with the requirements of local and national electrical codes.
- D. Control wiring in ducts, air plenums, air moving equipment, and other air handling spaces shall be specifically listed for the use, including wiring provided with field devices.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Inspect and examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- B. Install systems and materials in accordance with drawings and details, manufacturer's instructions, reviewed submittals, and contract documents. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications.
- C. Where components are installed in potentially wet or corrosive environments, install in an appropriate enclosure. Enclosures shall be of the type as indicated:
  - 1. Components installed in exterior locations or locations subject to moisture shall be installed in a NEMA 4 enclosure.
  - 2. Where possible, do not install components in corrosive environments. However, if the component must be installed in corrosive locations, it shall be installed in a NEMA 4X enclosure.

### **3.2 INSTALLATION OF CONTROLLERS**

- A. Install controllers in accordance with manufacturer's installation instructions and with adequate clearance to allow for maintenance.
- B. Install all controllers in a control panel enclosure. Control panels shall be of the type as indicated:
  - 1. Controllers installed in interior locations shall be installed in a NEMA 1 enclosure.
  - 2. Controllers installed in exterior locations or locations subject to moisture shall be installed in a NEMA 4 enclosure.
  - 3. Where possible, do not install controllers in corrosive environments. However, if the controller must be installed in corrosive locations, it shall be installed in a NEMA 4X enclosure and all associated components shall also be appropriate for the application and shall be approved by the Design Professional prior to installation.
- C. Label all control panel enclosures with the system or equipment served. Network controllers shall be labeled to indicate the general areas of the building served. All labels shall match the designations on the as-built drawings, which shall match the equipment tags on the plans.

- D. Include a copy of the as-built point-to-point wiring diagrams and final programmed sequence inside each control panel enclosure.

### 3.3 INSTALLATION OF FIELD DEVICES

#### A. General:

1. Install all field devices where indicated on the plans and in accordance with manufacturer's installation instructions and with adequate clearance to allow for proper operation, maintenance, and removal of the device.
2. Repair pipe insulation to maintain the integrity of the insulation vapor barrier. Use hydraulic insulating cement to fill voids and to repair damages to the factory applied vapor barrier. Finish with material matching or compatible with adjacent jacket material.
3. Repair duct insulation to maintain the integrity of the insulation vapor barrier. Use foil tape to repair damages to the factory applied vapor barrier.
4. Where a field device penetrates a duct or air moving equipment, seal around the penetration to prevent air leakage.

#### B. Room/Wall-mounted Sensors:

1. Install at the elevation indicated on the plans.
2. Install plastic guards over sensors with user adjustment where noted on the plans.
3. Provide insulated back panel where sensors are located on the inside face of an exterior wall or on a column enclosure.

#### C. Temperature Sensors:

1. Averaging Temperature Sensors: Install sensing element with equal spacing to provide uniform coverage of the face area.
2. Immersion Sensors: Coordinate the pipe size required to accept the probe diameter of the sensor without significant flow restriction with the HVAC and Plumbing Piping Contractor. All probes shall be installed in a minimum 1-1/4" pipe size.
3. Pipe Surface Mount Temperature Sensors (Strap-on): Use only where specifically indicated on the plans. Install with thermally conductive paste at the pipe contact point. Where sensor is to be installed on an insulated pipe, install probe under the insulation and secure around pipe with only the wire protruding from insulation. Seal around wiring to maintain the vapor barrier of the pipe insulation.
4. Freezestat: Install sensing element with equal spacing to provide uniform coverage of the face area. Adjust the low limit temperature setting as indicated on the plans or as required for the application.
5. Outdoor Air Temperature and/or Humidity Sensors: Install in the location shown on the plans. If not shown on the plans, contact the Design Professional.
6. Slab Sensors: Install sensor centered between parallel runs of tubing that are spaced at the typical design spacing. Locate sensor away from high foot traffic areas and away from paths of vehicular travel.

- D. Duct-mounted Relative Humidity Sensors: When installed downstream of a humidifier, install far enough downstream in airflow path to allow for full moisture absorption into the airstream at all operating conditions of the humidifier. When element guard is provided with the sensor, install upstream of the sensor.

- E. CO2 Sensors: Within one month prior to project substantial completion, calibrate all sensors. Provide calibration reports as part of the closeout documents.

- F. Specialty Gas Sensors (e.g. CO, NO<sub>2</sub>, etc.): Within one month prior to project substantial completion, calibrate all sensors. Provide calibration reports as part of the closeout documents.
- G. Occupancy Sensors: Wire to the extra contact on the occupancy sensor/room lighting controller provided by the Electrical Contractor.
- H. Differential Pressure Sensors:
  - 1. Duct Differential Pressure Sensors: Install in the location in the system shown on the plans. If not shown on the plans, contact the Design Professional.
  - 2. Water Differential Pressure Sensors: Install in the location in the system shown on the plans. If not shown on the plans, contact the Design Professional.
  - 3. Building Differential Pressure Sensors: Install in the location shown on the plans. Where not shown on the plans, contact the Design Professional.
- I. Air Differential Pressure Switches: For a positively pressurized duct, adjust the set point to be 0.25" less than the duct pressure classification rating. For a negatively pressurized duct, adjust the set point to be 0.25" more than the duct pressure classification rating. Unless indicated otherwise on the plans. Refer to the Duct Classification Schedule on the plans for duct pressure classification ratings.
- J. Thermal Mass Flow Measuring Stations (MFMS)
  - 1. Install in an unobstructed straight length of pipe in accordance with the manufacturer's recommendations based on the pipe fittings immediately upstream and downstream of the unobstructed straight length of pipe.
  - 2. If the MFMS is an insertion-type, install in a location with enough clearance to fully remove the sensor from the pipe.
- K. Airflow Measuring Stations (AFMS):
  - 1. Duct-mounted: Install in an unobstructed straight length of duct in accordance with the manufacturer's recommendations based on the duct fittings immediately upstream and downstream of the unobstructed straight length of duct.
  - 2. Fan inlet: Install one per fan where indicated on the plans.
  - 3. Where the AFMS comes with a remotely mounted display and the sensor is located in a mechanical room, the display shall also be located in the mechanical room. If the AFMS is located above a ceiling or in an occupied space, the display shall be located in the nearest mechanical, electrical, or custodial room, provided the distance is does not exceed the maximum allowed by the manufacturer. Mount the display within 7 ft AFF.
  - 4. If the AFMS is an insertion probe-type, install in a location with enough clearance to fully remove the probe from the duct.
- L. Water Flow Measuring Stations (WFMS)
  - 1. Install in an unobstructed straight length of pipe in accordance with the manufacturer's recommendations based on the pipe fittings immediately upstream and downstream of the unobstructed straight length of pipe.
  - 2. If the WFMS is an insertion-type, install in a location with enough clearance to fully remove the sensor from the pipe.



- M. BTU Meter: Install meter so the display is within 7 ft of the floor. If the BTU meter is located above a ceiling or in an occupied space, the display shall be located in the nearest mechanical, electrical, or custodial room, provided the distance is does not exceed the maximum allowed by the manufacturer.
- N. Control Valves: Install so that the valve stem axis is vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal or down.
- O. Current Switch: Adjust so that the set point is below the minimum operating current and above motor no load current.
- P. Wall-mounted Audible and Visible Alarms: Install device at 6'-8" above finished floor. Install silence button at 46" AFF and below the audible and visible alarm.
- Q. Wall-mounted Push Buttons: Install at the elevation indicated on the plans.

### **3.4 INSTALLATION OF CONTROL WIRING**

- A. The BAS Contractor shall provide a complete Tier 1 level communication network dedicated to all BAS communications, including all required wiring and network switch(es), as applicable. The BAS Contractor shall only utilize the connection port(s) indicated specifically for BAS use on the telecommunications plans. Additional connection ports shall not be utilized.
- B. Any equipment specified to be on emergency power shall also have all associated controls on emergency power, including all network controllers, local controllers, devices, etc.
- C. Control wiring shall be routed in blue conduit in the following locations: concealed in walls, concealed above inaccessible ceilings, finished areas with exposed structure, inside air moving equipment or ductwork, locations subject to moisture, exterior locations, and in all unfinished spaces, such as mechanical rooms, electrical rooms, etc. Where conduit is in an exterior location or subject to moisture, it shall be rigid and sealed to be watertight. Control wiring shall not share conduit with line voltage wiring.
- D. Control wiring routed to devices in accessible locations may be routed in flexible conduit. The minimum size of the flexible conduit shall be 1/2" and the maximum length shall be 36".
- E. Control wiring concealed by accessible construction may be installed without conduit. Accessible locations include areas such as above accessible ceilings and below accessible floors. Control wiring shall not share cable tray with telecommunications wiring or raceways with any other trade. All wiring shall be neatly routed and tie-wrapped to structural components, supported at least every 4 feet. Excess wire shall be neatly coiled and secured to structure. Under no circumstances shall cable be supported by piping, conduit, ductwork, ceiling tile or ceiling support wires. Cable shall be neatly routed in line with building lines.
- F. Install all control wiring to meet all manufacturer installation requirements, including not exceeding the maximum cable length, tension, or bend radius. At all building expansion joints, provide means for movement of wiring and conduit that exceeds the expected movement of the building.
- G. Label or color code each control wire at each end. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color coded cable with cable diagrams may be used to accomplish cable identification.

- H. Splices shall not be made in shielded wiring.

### **3.5 SYSTEM ACCEPTANCE**

- A. System Verification and Testing Procedure: The BAS Contractor shall confirm the system is complete, including all controls installed, graphics complete, and software programs have been completely tested and exercised for proper equipment operation. BAS control panels shall be demonstrated via a functional end to end test such that:
  - 1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operation verified.
  - 2. All analog input channels shall be verified for proper operation.
  - 3. All binary input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
  - 4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
  - 5. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
  - 6. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
- B. System Demonstration: After the BAS Contractor has confirmed proper operation, acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of the request. At that time, the BAS Contractor shall demonstrate the operation of the system to the Owner's Representative and Design Professional. Any issues are discovered during this demonstration shall be corrected.
- C. Operation and Maintenance Manuals: Submit copies of operation and maintenance manuals as required by this section and section 23 00 10 – HVAC General Provisions.

**END OF SECTION 23 09 00**

## SECTION 23 21 13 - HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
  - 1. Extent of hydronic piping work is indicated on drawings and schedules, and by requirements of this section.
  - 2. Insulation of hydronic piping is specified in other Division 23 sections, and is included as work of this section.
  - 3. Installation of valves for hydronic piping system is specified in other Division-23 sections and is included as work of this section.

#### 1.3 QUALITY ASSURANCE

- A. ASME Compliance: Fabricate and install hydronic piping in accordance with ASME B31.9 "Building Services Piping".
- B. UMC Compliance: Fabricate and install hydronic piping in accordance with the "Uniform Mechanical Code".
- C. IMC Compliance: Fabricate and install hydronic piping in accordance with the "International Mechanical Code".

#### 1.4 SUBMITTALS

- A. Submit manufacturer's submittal information including cut sheets, material data, and product specifications.

#### 1.5 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Copper Pressure-Seal Fittings
  - 1. Viega Pro Press
  - 2. NIBCO Press System

B. Expansion tanks

1. Amtrol/Thrush
2. Bell & Gossett
3. Taco
4. Wheatley
5. Spirotherm
6. Armstrong
7. Patterson Pump

C. System fill pressure valve, air vents and other hydronic accessories

1. Amtrol/Thrush
2. Bell & Gossett
3. Taco
4. Wheatley
5. Armstrong
6. Patterson Pump

D. Air and Air/Dirt Separator

1. Spirotherm
2. Thrush
3. Wheatly
4. Bell & Gossett
5. Taco
6. Armstrong

E. Coil Piping Packages

1. Pro Hydronic Specialties
2. Griswold
3. IMI Flow Design Inc.
4. NuTech Hydronic Specialty Products

F. Automatic Flow Control Valves

1. IMI Flow Design Inc. (Autoflow)
2. Griswold
3. Pro Hydronic Specialties

H. Manual Balancing Valves

1. Bell & Gossett
2. Tour & Andersson/Victaulic
3. IMI Flow Design Inc. (Flow Set)
4. Pro Hydronic Specialties
5. Griswold
6. NuTech Hydronic Specialty Products

I. Strainers

1. Apollo

2. Watts
  3. Keckley
  4. Metraflex
  5. Titan
  6. IMI Flow Design Inc. (Autoflow)
  7. Griswold
  8. SF Equipment
  9. Pro Hydronic Specialties
- J. Chemical Treatment Feeder/Filter
1. Neptune
  2. JL Wingert
  3. General Treatment Products
  4. Armstrong
  5. Skidmore
- K. Side Stream Filter
1. Global Filter
  2. LeSac
- L. Cooling Tower Chemical Treatment
1. Ecolab
- M. Triple Duty Valve
1. Amtrol/Thrush
  2. Bell & Gossett
  3. Taco
  4. Armstrong
  5. Paco
  6. Patterson Pump
- N. Water Meters
1. Badger
  2. Neptune
- O. Coupon Rack
1. Metal Samples
  2. JL Wingert
- P. Buffer Tanks
1. Wessels
  2. Woulds
  3. Lochinvar
  4. Cemline
  5. Laars
  6. Wheeler

**2.2 BASIC MATERIALS AND PRODUCTS**

- A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ASME B31.9 "Code for Building Services Piping" where applicable, base pressure rating on hydronic piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in hydronic piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Valves: Refer to Section 23 05 23 - General Duty Valves for HVAC Piping.
- C. Piping Specialties: Refer to Section - 23 05 00 - Common Work Results for HVAC.
- D. Expansion Compensation: Refer to Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
- E. Meters and Gauges: Refer to Section 23 05 19 - Meters and Gages for HVAC Piping.
- F. Supports, Anchors and Seals: Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping.

**2.3 PIPE:**

- A. Provide pipe materials meeting the following criteria and referenced standards:
  - 1. Black Steel pipe (St Blk 80): Schedule 80, ASTM A53.
  - 2. Black Steel pipe(St-Blk 40): Schedule 40, ASTM A53.
  - 3. Type K Copper (K Cu): Type K copper water tube, hard temper, ASTM B88.
  - 4. Type L Copper (L Cu): Type L copper water tube, hard temper, ASTM B88.
  - 5. Polyvinyl Chloride (PVC): Schedule 40, ASTM D1785 and ASTM D2665.
- B. Unless specifically prohibited by local codes, provide piping materials for systems indicated according to the following table:

Service	Material					
	St-Blk 80	St-Blk 40	K Cu	L Cu	PVC	
Hot and Chilled water (welded)		X		X		
Hot and Chilled water (threaded)	X					
Hot, Chilled & Heat Pump water 2” and larger		X				
Condensate Drain Lines below slab			X			
Condensate Drain Lines – above slab				X	X	
Condensate Drain Lines – Condensing Heater					X	

**2.4 FITTINGS:**

- A. Copper water tube cast bronze or wrought copper:
  - 1. Solder joint type. ANSI B16.18 and B16.22-63.
  - 2. Pressure-Seal pipe joining system, copper press fittings, 1/2" to 4” in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM. Installation per manufacturer’s recommendations.

3. Mechanical grooved and roll-groove copper piping system and fittings: may be used as approved by code for copper piping. Grooved piping shall not be used in areas where piping is routed above finished ceilings(drywall or lay-in) for chilled water systems. All components shall be by one manufacturer. System installation shall be in accordance with the manufacturer's recommendations.

B. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Malleable iron fittings, 125 pound standard flat band water pattern.
2. Welded pipe (2 1/2" dia and larger): Standard radius weld fittings and weld neck or slip-on flanges, same material and strength as pipe.

## 2.5 JOINTS

A. Copper water tube:

1. Use non-corrosive 95-5 tin-antimony solder, cut pipe square, clean, ream and polish tube ends and inner surfaces of fittings, apply flux and solder joint as recommended by manufacturer of solder type fittings.
2. Pressure-Seal pipe joining system, copper press fittings, 1/2" to 4" in diameter. ASME B16.18, ASME B16.22. O-rings for copper press fittings shall be EPDM.

B. Steel Pipe:

1. Threaded pipe (2" dia and smaller): Make joints using Teflon tape applied to male threads only. Cut pipe square, cut threads clean, remove burrs and ream ends to full size of bore. For fuel piping and lubricating oil piping, joint sealing material shall be resistant to petroleum products.
2. Welded pipe (2 1/2" dia and larger): Welding shall conform to welding section of ANSI-B31.3 "Code for Power Piping."

## 2.6 NIPPLES AND UNIONS

- A. All nipples shall conform to size, weight and strength of adjoining pipe. When length of unthreaded portion of nipple is less than 1-1/2", use extra strong nipple; do not use close nipples.
- B. For pipe 2" and smaller, use screwed unions, for pipe 2-1/2" and over use flanged unions. For steel pipe use black or galvanized malleable iron unions, to conform to pipe with ground joint. Cast iron flanged unions gasket type.
- C. Install unions in the following locations so that a minimum amount of pipe need be disassembled:
  1. Long runs, at intervals of 80 feet.
  2. In by-pass around equipment, valves, and controls.
  3. In connections to equipment.
  4. Where indicated on drawings.
- D. Dielectric unions shall be installed between any connection of copper pipe and ferrous piping or equipment.

## **2.7 EXPANSION TANKS**

- A. Furnish and install pre-charged steel expansion tanks as indicated on plans. Tanks shall have replaceable heavy-duty Butyl rubber bladder, a 1" or 1-1/2" NPT system connection, 3/4" NPT drain, and a .302"-32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation. The tank shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125 PSI working pressure.

## **2.8 AIR AND DIRT SEPARATOR**

- A. Furnish and install units as indicated on plans. Air and dirt removal device shall be constructed of steel and shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 125 psi (150 psi) at 270 deg. F.
- B. Units up to two inch size shall be provided with threaded connections as standard. Units larger than two inch shall be provided with flanged system connections as standard. Inlet and outlet connections to be inline with piping system, both inlet and outlet to be in the same horizontal and vertical planes.
- C. Each air and dirt removal device shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly.
- D. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and removal of the floating impurities from the air system interface within the separator.
- E. A blow down valve shall be provided by the unit manufacturer on the bottom of each unit to allow blow down and cleaning. On units 2-1/2" and smaller the valve and all of its fittings shall be 1". On units 3" and larger the valve and all openings shall be 2".
- F. The air and dirt removal device shall remove air down to 18 microns and shall remove dirt/debris down to 35 microns. The unit shall be 100% efficient at removing dirt down to 90 microns in 100 passes or less.
- G. The air and dirt separator shall have a flanged bottom to allow the removal of the strainer and cleaning inside the unit.

## **2.9 BUFFER TANKS**

- A. Furnish and install Buffer Tanks as indicated on the plans. Tank shall be constructed of steel and shall be designed, fabricated and stamped per ASME Section VIII Division 1 with a maximum working pressure of 125 psi at 450 Deg F. Provide tank constructed with inlet, outlet and baffle arrangement to avoid stratification.

## **2.10 SYSTEM FILL PRESSURE VALVE**

- A. Iron body, brass trim with field adjustable pressure setting. Bell & Gossett Model No. 12.

## **2.11 AIR VENTS**

- A. Manual Air Vents: Bell & Gossett Model No. 4V.



## **2.12 PRESSURE & TEMPERATURE TEST STATIONS**

- A. Supply and install in an accessible position, Peterson Equipment Company #110 "Pete's Plug", or equal, 1/4" MPT fitting ("110 XL for insulated piping) to receive either a temperature or pressure probe 1/8" O. D. in the supply and return piping of all chillers, coils, fan coil units, heat exchangers, water pumps, and on all hot water and chilled water, supply and return mains. Fitting shall be solid brass with two (2) valve cores or Nordel (maximum 275 deg. F. at 500 PSI), fitted with a color coded and marked cap with gasket and shall be rated at 1000 PSIG. Single valve core or Neoprene valve core devices are unacceptable.
- B. Meters and Instruments The installing contractor shall supply and present to the owner upon completion of testing, one Series 1500 XL pressure and temperature test kit, consisting of a 0 100 PSI, 0 230 ft. of water pressure gauge with No. 500 gauge adapter attached, a 25 125 deg. F. pocket testing thermometer, a 0 220 deg. F. pocket testing thermometer, a No. 500 gauge adapter, and a protective carrying case.

## **2.13 COIL PIPING PACKAGE**

- A. Coil piping package shall include combination isolation valve and strainer, union for inlet and outlet coil connections, union connections for temperature control valve, and flow limiting device with integral isolation valve. All components (excluding balancing valve) shall be line size without reductions.
- B. Combination Valve/Strainer: Shall include a combination valve, Y-strainer and union with two extended temperature/pressure test ports and hose end drain valve with cap and chain.
  - 1. Strainer shall be 20 mesh stainless steel screen.
  - 2. Valves up to 2" shall be ball valve with blow-out proof stem and stainless steel ball.
  - 3. Valves larger than 2" shall be butterfly type, carbon steel body with bronze seat, bronze disc with EPDM seal and stainless steel stem.
- C. Unions: Provide union for inlet and outlet connections to coil and for temperature control valve installation. Union at outlet of coil shall include manual air vent and pressure/temperature port.
- D. Manual Balancing Valve:
  - 1. Valves up to 2" shall be ball type valve with brass body and stainless steel ball construction, glass and carbon fitted TFE seat rings, extended readout ports with integral check valves and gasketed caps, drain port, calibrated nameplate and position indicator, memory stops, and NPT connectors, rated for 300 psig at 250 deg. F.
  - 2. Valves larger than 2" shall be lugged butterfly type valve with carbon steel body, bronze seat, bronze disc with EPDM seal insert, stainless steel stem, readout ports with integral check valves and gasketed caps, drain port, calibrated nameplate and position indicator, memory stops, and flanged connection rated for 175 psig at 250deg. F.
  - 3. Valves to be selected for 5 ft. pressure drop at full open setting and design water flow.
  - 4. Provide identification, by metal tag with chain or visible sticker, providing zone identification and balanced flow rate (GPM).

## **2.14 MANUAL BALANCING VALVES**

- A. Provide calibrated manual balancing valves where indicated on the plans.

- B. Construction:
  - 1. 1/2" to 2" ball type valve with brass body and stainless steel ball construction, glass and carbon fitted TFE seat rings, extended readout ports with integral check valves and gasketed caps, drain port, calibrated nameplate and position indicator, memory stops, and NPT connectors, rated for 300 psig at 250 deg. F.
  - 2. 2 1/2" to 12" butterfly or globe style valve with cast iron or carbon steel body, bronze seat, stainless steel stem, readout ports with integral check valves and gasketed caps, drain port, calibrated nameplate and position indicator, memory stops, and flanged connection rated for 175 psig at 250 deg. F
- C. Valves to seal leak-tight at maximum rated working pressure.
- D. Valves to be selected for 5 ft. pressure drop at full open setting and design water flow.
- E. Provide identification, by metal tag with chain or visible sticker, providing zone identification and balanced flow rate (GPM).

**2.15 STRAINERS**

- A. Strainers shall be Y-strainers with hose end drain valve with cap and chain (and shall be independent of isolation valve). ANSI Class 125 cast bronze or cast iron.
- B. Y-strainers shall be 20 mesh stainless steel screen with removable cap.

**2.16 WATER METERS (HYDRONIC SYSTEM MAKE UP)**

- A. Lead-Free bronze body with sealed register, manual water meter for monitoring hydronic system make-up supply line. Meter shall meet all applicable AWWA standards for installation in potable water system.

**2.17 SUPPLY AND RETURN HOSES**

- A. All hoses shall be a minimum of 12 inches in length and equipped with swivel end connections at terminal unit. All end connections shall be crimped to meet stated pressure ratings. Serrated/slip fit connections are not acceptable.
- B. Hose materials shall be high quality polyethylene pipe insulation over a stainless steel braided inner core and withstand working pressure of 375 PSI (1/2"), 300 PSI (3/4"), 225 PSI (1"), 200 PSI (1-1/4") at 211 deg. F and 175 PSI (1-1/2") and 150 PSI (2") at 200 deg. F.

**2.18 CHEMICAL TREATMENT FEEDER/FILTER**

- A. General
  - 1. Furnish and install a water treatment system including chemicals for the loop water system for the control of system corrosion. The water treatment equipment shall be installed by Contractor under the supervision of the water treatment company and shall be responsible for check out and start up of all water treatment equipment. Provide a written, certified report upon completion of startup. The system shall include the following:
    - a. One 5 gallon bypass filter/feeder with strainer and 25 micron filter. Filter/feed shall be installed at a height for convenient access. The bypass feeder, 3/4" inlet and outlet gate valves, 1/2" drain valve, reducing tee, unions and nipples provided shall be suitable for use at 125 psig.

- b. Initial chemical treatment chemicals.
2. Provide one year of chemicals and service by a qualified, full-time representative of the water treatment company.

## **2.19 COUPON RACKS**

- A. Coupon racks shall consist of 1" schedule 40 black steel piping, four stations, automatic balance valve, and four fixed coupon holders for cylindrical coupons. Part #TF2440A59. Coupons provided with the coupon rack shall be turned over to the Owner.

## **2.20 COOLING TOWER CHEMICAL TREATMENT**

- A. Furnish and install a water treatment system including chemicals for the cooling tower water system. The treatment system shall be meter initiated in the amount of chemical injection and cooling tower bleed off shall be in proportion to the amount of makeup water entering the system.
- B. The water treatment equipment shall be installed by Contractor under the supervision of the water treatment company and shall also be responsible for check out and start up of all water treatment equipment. The system shall include the following:
  1. One 2 inch water meter Carlon, 2" JSJ200, equipped with an electrical contacting head. The electrical contacting head shall be of the micro switch type. The closure of frequency shall be pre selected such that the two interval timers shall have sufficient time to time out between cycles.
  2. One dual sequence timer shall contain two interval timers each adjustable from 0 - 5 minutes and be of the automatic resetting type. The interval timers shall be field adjustable for simultaneous or sequential operation. Each interval timer shall have at least one set of normally open SPST contacts rated at 10 amps at 125 volts AC. The dual sequence timer, solid state dual timer Model LEP DST, shall operate at 125 volts AC, 60 cycles. Both interval timers shall be mounted in a single enclosure. A 14 terminal barrier strip shall be included within the dual sequence timer for all external connections. The dual sequence timer shall be equipped with pilot lights to indicate power on, timing cycle in progress, push to test button, fuse and an on off switch.
  3. One treatment chemical feed pump which shall be an electronic pulse, positive displacement type pump, PCP Model 10681 11P. Output volume shall be adjustable while pump is in operation from 0 to a maximum capacity of 14 gallons per day. Adjustment shall be by means of two dial knobs; one for changing stroke length and the other for changing stroke frequency. The chemical metering pump shall be capable without a hydraulic backed diaphragm of injecting chemicals against pressures of up to 100 psig.
  4. To eliminate the need for a pressure relief valve, the pump shall automatically stop pulsing where discharge pressure exceeds pump pressure rating by not more than 35%.
  5. The chemical metering pump housing shall be of chemical resistant glass fiber reinforced thermoplastic. All exposed fasteners shall be of stainless steel. The chemical metering pump valve shall be ball type with ceramic ball seating on a combination valve seat and seal ring. The valve seat and seal ring shall be renewable by replacing only the combination seat/seal ring which shall be made of Viton. Fittings and connections at the pump head shall be sized for 3/8" OD tubing.
  6. Initial chemical treatment chemicals.
- C. Furnish and install all materials, chemicals and components required to passivate cooling tower in accordance with manufacturer's instructions. Include all costs associated with monitoring cooling tower water throughout duration of passivation as required by cooling tower manufacturer. Furnish passivation certificate to demonstrate compliance with manufacturer's requirements.

## **2.21 TRIPLE DUTY VALVE**

- A. Furnish and install as shown on plans, a Triple Duty valve designed to perform the functions of a non-slam check valve, throttling valve, shut off valve, calibrated balancing valve and system flowmeter. The valve shall be of heavy-duty cast iron construction with standard 125 psig ANSI flanged connections, and rated for a maximum working pressure of 175 psig at 250 deg. F. The valve shall be fitted with an EPDM soft seat, replaceable bronze disc, stainless steel stem and chatter preventing spring. The valve design shall permit repacking under full system pressure.
- B. Each valve shall be equipped with brass readout valves (with integral check valve) for taking differential pressure readings across the orifice to accurately balance the system to specified design conditions.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. General: Examine areas and conditions under which hydronic piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

### **3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS**

- A. General: Install basic materials and products as required per manufacturer's recommendations, ASME B31.9 "Code for Building Services Piping", and as required to meet the intent of the documents.
- B. Valves
  1. Refer to Section 23 0523 - General Duty Valves for HVAC Piping.
  2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.
  3. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves 2 or more hydronic terminals or equipment connections, and elsewhere as indicated.
  4. Shutoff Valves: Install on inlet and outlet of each mechanical equipment item, and on inlet of each hydronic terminal, and elsewhere as indicated.
  5. Drain Valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic piping system.
  6. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
- C. Piping Specialties: Refer to Section 23 05 00 - Common Work Results for HVAC.
- D. Expansion Compensation Products: Refer to Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
- E. Meters and Gauges: Refer to Section 23 05 19 - Meters and Gages for HVAC Piping.
- F. Supports, Anchors and Seals: Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

### **3.3 HYDRONIC PIPING**

- A. Install pipe for all hydronic systems as indicated on drawings, as called for in other sections, and as specified herein.
- B. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other trades. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
- C. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage.
- D. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.
- E. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
- F. Install automatic temperature control valves and other items as called for to be installed in piping and furnished by Section 23 09 00 - Building Automation System (BAS).
- G. Provide air vents at all high points in the system and capped drain valves at all low points in the system.
- H. Branch take off pipe connections shall come off the top of the mains.

### **3.4 HYDRONIC SPECIALTIES**

- A. Air separator shall not be supported by piping; install pipe hanger at inlet and outlet.
- B. Install pressure reducing and fill valves as indicated and make cold water connection. Install fast fill bypass line with globe valve.
- C. Install manual air vents for each terminal unit coil and at other points likely to entrap air including all high points in the system piping.
- D. Maintain access to pressure and temperature test stations.
- E. Install backflow preventers in accordance with manufacturer's recommendations. Installing Contractor shall provide testing by a certified backflow assembly tester at the time of installation as required by the Uniform Plumbing Code. Install air gap fitting and pipe to nearest floor drain.

### **3.5 EQUIPMENT CONNECTIONS**

- A. General: Connect hydronic piping system to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.

- B. Hydronic Terminals: Install hydronic terminals with valve and union on outlet; union, shutoff valve on inlet. Install manual air vent on element in accordance with manufacturer's instructions. Locate valves and balancing cocks behind valve access doors for ease of maintenance. Where indicated, install automatic temperature control valve with unions between valve and element on supply line.

### **3.6 FIELD QUALITY CONTROL**

- A. Piping Tests: Test hydronic piping in accordance with testing requirements of Division 23 Basic Materials and Methods, Section 23 00 10 - HVAC General Provisions.
- B. Expansion tank and other components not rated for the full system pressure test pressure shall be isolated from the system during testing.

### **3.7 SYSTEM FLUSHING AND CLEANING**

- A. Flushing and Inspecting: Clean, flush and inspect hydronic piping systems to remove contaminants prior to filling with heat transfer fluid. Refer to section 23 0010 for additional information/requirements.
  - 1. Fill system with high quality water and 1 to 2 percent Tri-Sodium Phosphate or approved equivalent cleaning solution.
  - 2. Circulate solution for 8 to 12 hours and flush solution from the system with high quality water.
  - 3. Circulate the flushed system with clean water for a minimum of 72 hours. Ensure fluid flow direction in all piping matches normal system flow direction and at a minimum velocity of 5 fps.
  - 4. After 72 hours, take samples to verify the system is free of particulates, mil scale, weld scale, solder, flux, rust, metal filings, oil grease, chlorides, sulfates, silicates, and other foreign matter that could degrade the heat transfer fluid.
- B. Circulate and relieve air from high points in the entire system (both new and existing portions for renovation projects) for minimum of 48 hours to ensure all air is removed from the system prior to start up of connected equipment.

### **3.8 SYSTEM FILL**

- A. Chemical Treatment: Refill hydronic piping systems, adding caustic soda to maintain ph of 8.0 to 8.5 and sodium sulfate in amount of 1/3 caustic soda or to maintain residual of 30 to 40 ppm in system. Add trisodium phosphate to make hardness of 0 ppm and residual of approximately 30 ppm in system. Repeat measurements daily with system under full circulation and apply chemicals to adjust levels until no change is apparent.

**END OF SECTION 23 21 13**

## SECTION 23 21 23 - HYDRONIC PUMPS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of HVAC pumps work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of pumps specified in this section include the following:
  - 1. In-line Pumps
  - 2. End Suction Base Mounted Pumps
  - 3. Centrifugal Separators
- C. Refer to Section 23 0513 Common Motor Requirements for HVAC Equipment for detailed motor requirements.
- D. Refer to Division-26 sections for the following work; not work of this section:
  - 1. Power supply wiring from power source to power connection on pumps. Include starters, disconnects and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.

#### 1.3 QUALITY ASSURANCE

- A. UL Compliance: Design, manufacturer and install HVAC pumps in accordance with UL 778 "Motor Operated Water Pumps".
- B. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to HVAC pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

## **1.5 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

## **1.6 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Handle HVAC pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged HVAC pumps or components; replace with new.
- B. Store HVAC pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Pumps
  - 1. Aurora
  - 2. Bell & Gossett ITT; Fluid Handling Div.
  - 3. Taco, Inc.
  - 4. Armstrong
  - 5. Grundfos / Paco
  - 6. Patterson Pump
- B. Centrifugal Separators
  - 1. Puroflux
  - 2. Pep Filters
- C. Pump Connectors
  - 1. Keflex
  - 2. Metraflex
  - 3. Twin City Hose
  - 4. Minnesota Flexible
  - 5. Mason
- D. Suction Diffusers
  - 1. Aurora
  - 2. Bell & Gossett
  - 3. Taco, Inc.
  - 4. Armstrong
  - 5. Grundfos
  - 6. Patterson Pump
  - 7. Victaulic



- E. General: Provide factory tested pumps, thoroughly cleaned and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

### **2.3 IN-LINE PUMPS**

- A. General: Provide in-line centrifugal pumps where indicated, and of capacities as scheduled.
- B. Type: Single-stage, close-coupled, vertical split case design, horizontal or vertical mount, designed for 175 psi working pressure, and 225 deg. F continuous water temperature.
- C. Construction: Cast iron body with suction and discharge flanges, gauge (suction and discharge), vent and drain ports. Solid steel shaft with bronze shaft-sleeve, mounted on heavy-duty grease lubricated ball bearings. Internally flushed, carbon, mechanical seals installed in an enlarged tapered seal chamber. The pump internals shall be capable of being serviced without disturbing piping connections.
- D. Impeller: Brass or bronze, hydraulically and dynamically balanced, keyed to the shaft and secured by a locking capscrew or nut.
- E. Coupling: A flexible type coupling shall be employed between the pump and motor.
- F. Motor: Motors shall have heavy-duty grease ball bearings. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
- G. Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

### **2.4 BASE MOUNTED END SUCTION PUMPS**

- A. General: Install Base Mounted End-Suction Pumps where indicated, and of capacities as scheduled.
- B. Type: Base mounted, single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections. Pumps shall be designed for 175 psi working pressure, and 225 deg. F continuous water temperature.
- C. Construction: Class 30 cast iron body with integrally-cast pedestal support feet, suction and discharge flanges, gauge (suction and discharge), vent and drain ports. Solid steel shaft with bronze shaft-sleeve, mounted on heavy-duty grease lubricated ball bearings. Internally flushed, carbon, mechanical seals. The pump internals shall be capable of being serviced without disturbing piping connections. Provide with wear rings.
- D. Impeller: Cast bronze, hydraulically and dynamically balanced, keyed to the shaft and secured by a locking stainless steel cap screw or nut.
- E. Coupling: A flexible type, center drop-out design coupling shall be employed between the pump and motor. Pumps for variable speed application shall have suitable coupling design for application. Coupling shield shall be OSHA complaint and include an inspection window.
- F. Motor: Motors shall have heavy-duty grease lubricated ball bearings. Motors shall be non-overloading at any point on the pump curve Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by Contractor after installation.

- G. Base: Structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully opened.
- H. Each pump shall be factory tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

## **2.5 CENTRIFUGAL SEPARATORS**

- A. Centrifugal separator to be a skid mounted pumping package to be connected to the Cooling Tower basin sweeper piping. Centrifugal separator to be capable of removing particles as low as 45 microns and to be rated for 150 psi working pressure. System components:
  - 1. Fusion bond polyester coated separator vessel.
  - 2. Manual air bleed valve
  - 3. Inlet/Outlet pressure gauges
  - 4. Centrifugal pump
  - 5. TEFC motor
  - 6. Cast iron pre-strainer
  - 7. Fusion-bond polyester coated carbon steel skid
  - 8. Electrically actuated automatic purge ball valve
  - 9. Adjustable purge timer
  - 10. Interconnecting Schedule 80 PVC piping
  - 11. UL labeled control panel
  - 12. Door disconnect switch
  - 13. Motor starter with short-circuit overload protection
  - 14. Local/Off/Remote switch
  - 15. Pump Status/Trip dry contact signals
- B. Centrifugal separator pump skid size: 400 GPM at 10 horsepower motor. Pump connection inlet to be 4 inch and outlet to be 4 inch with a tank separator volume of 15 gallons. Dimensions of skid to be approximately 40 inches Long x 36 inches Wide x 60 inches High.

## **2.6 SUCTION DIFFUSERS**

- A. Suction Diffuser: Provide at each base mounted end suction pump a Suction Diffuser, size to match pipe x pump inlet dimensions. Units shall consist of angle type cast iron body with steel straightening vanes and steel combination Diffuser Strainer-Orifice Cylinder with 3/16" diameter openings for pump protection. A permanent magnet shall be located within the flow stream and shall be removable for cleaning. The orifice cylinder shall be equipped with a disposable fine mesh bronze strainer which shall be removed after system start-up and replaced with permanent strainer. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross section area of pump suction opening. Straightening vanes shall extend the full length of the orifice cylinder and shall be replaceable. Unit shall be provided with adjustable support foot to carry weight of suction piping.

## **2.7 PUMP CONNECTORS**

- A. Pump Connectors to be braided type, corrugated hose with stainless steel, Metraflex Metra-Mini Series. For pipes sizes up through 4" diameter, minimum hose length to be 9". For pipe sizes 5" and larger, minimum hose length to be 11".

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Examine areas and conditions under which HVAC pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable with Installer.

### **3.2 INSTALLATION OF PUMPS**

- A. General: Install HVAC pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that HVAC pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Support:
  - 1. Support: Support in-line pumps from structure independent from piping. Provide spring vibration isolation for both pump supports and piping supports.
  - 2. Support: Grout base mounted pumps to housekeeping pads with non-shrinking grout in accordance with manufacturer's recommendations. Level pumps as required prior to grouting.
  - 3. Support: Install pump on concrete inertia base. See Section 23 0548 - Vibration Controls for HVAC Piping, Ductwork and Equipment for vibration isolation of piping system.
- D. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer for power wiring.
  - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- E. Piping Connections: Refer to Division-23 HVAC piping sections. Provide piping, valves, accessories, gauges and supports as indicated, including the following:
  - 1. Flexible connector in suction and discharge line of base mounted pumps.
  - 2. Shut-off valve in suction line.
  - 3. Check valve, balancing valve and shut-off valve in discharge line. For pipe sizes 2" and larger, check valve to be spring loaded silent type. At Contractor's option, an indicating type butterfly valve may be used in lieu of balancing cock and shut-off valve.
  - 4. Compound gauge with turn cocks connected between pump suction and discharge. For pumps with suction diffusers, provide connection at inlet to suction diffuser as well along with turn cock.

### **3.3 ALIGNMENT AND START-UP**

- A. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- B. Start-up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.

- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

### **3.4 INSTALLATION OF PUMPS - ALIGNMENT**

- A. Provide factory-authorized service representative to perform alignment service after installation of the pumps is completed.
- B. Comply with requirements in Hydronics Institute Standards for alignment of pump and motor shaft. Perform initial alignment at ambient temperature and perform subsequent alignment with pump at operating temperature. Laser alignment of the pumps shall be included.

### **3.5 START-UP SERVICE**

- A. Provide factory-authorized service representative to perform start-up service after installation of the pumps is completed.
  - 1. Complete manufacturer's recommended start-up checks.
  - 2. Verify piping connections are adequate and inlet strainer is clean.
  - 3. Verify bearing lubrication and that pump is rotating in the correct direction.
  - 4. Verify required performance parameters, including discharge pressure, noise, and vibration.

### **3.6 OWNER TRAINING**

- A. Provide factory-authorized service representative to provide training of Owner's maintenance personnel to adjust, operate, and maintain pumps. Refer to Section 01 77 19 – Contract Closeout for additional information on training requirements.

**END OF SECTION 23 21 23**

## SECTION 23 23 00 - REFRIGERANT PIPING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to fabricate and install complete piping system as required by the drawings and this section.
  - 1. Extent of refrigerant piping work is indicated on drawings and schedules, and by requirements of this section.
    - a. Refrigerant suction line piping between compressors and cooling coils.
    - b. Refrigerant liquid line piping between liquid receivers and cooling coils.
  - 2. Insulation of refrigerant piping is specified in other Division 23 sections and is included as work of this section.
  - 3. Installation of valves for refrigerant piping system is specified in other Division-23 sections and is included as work of this section.

#### 1.3 QUALITY ASSURANCE

- A. ANSI Code Compliance: Comply with applicable provisions of ANSI B31.5, "Refrigeration Piping", and extend applicable lower pressure limits to pressures below 15 psig.
- B. Safety Code Compliance: Comply with applicable portions of ANSI ASHRAE 15, "Safety Code for Mechanical Refrigeration".
- C. UMC Compliance: Fabricate and install refrigeration piping in accordance with IAMPO "Uniform Mechanical Code".
- D. IMC Compliance: Fabricate and install refrigeration piping in accordance with "International Mechanical Code".

### PART 2 - PRODUCTS

#### 2.1 BASIC MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 "Code for Refrigeration Piping" where applicable, base pressure rating on refrigeration piping system's maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigeration piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.
- B. Valves: Refer to Section 23 05 23 - General Duty Valves for HVAC Piping.
- C. Piping Specialties: Refer to Section - 23 0 500 - Common Work Results for HVAC.

D. Supports, Anchors and Seals: Refer to Section 23 0529 - Hangers and Supports for HVAC Piping.

## 2.2 PIPE:

	<u>Material</u>	<u>Service</u>
A.	Copper refrigeration tube, soft temper. Type L-ACR. ASTM B280.	Refrigerant lines for systems 5 tons and less.
B.	Copper refrigeration tube, hard. temper. Type L-ACR. ASTM B280.	Refrigerant lines for systems over 5 tons.

## 2.3 FITTINGS:

- A. Copper refrigerant tubes:
1. 3/4" and Smaller: Cast copper alloy for flared copper tubes.
  2. 7/8" through 4 1/8": Wrought copper, solder joints.

## 2.4 JOINTS

- A. Copper refrigerant tube:
1. 3/4" and Smaller: Flared.
  2. 7/8" through 4 1/8': Soldered, silver lead solder, ANSI/ASTM B 32, Grade 96 TS.

## 2.5 INSULATION

- A. Refer to section 23 07 00 for insulation thickness requirements on factory pre-insulated line sets.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. General: Examine areas and conditions under which refrigerant piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

### 3.2 INSTALLATION OF BASIC MATERIALS AND PRODUCTS

- A. General: Install basic materials and products as required per manufacturer=s recommendations, ANSI B31.5 A Code for Refrigerant Piping" and as required to meet the intent of the documents.
- B. Refrigerant Piping
1. Install pipe for all refrigerant systems as indicated on drawings, as called for in other sections, and as specified herein.
  2. Arrange and install piping approximately as indicated; straight, plumb, and as direct as possible; form right angles on parallel lines with building walls. Keep pipes close to walls and avoid interference with other refrigerant items. Locate groups of pipes parallel to each other; space at a distance to permit applying full insulation and to permit access for servicing valves. Most piping to be run in concealed locations unless indicated exposed, or in equipment rooms. Locate piping to avoid ductwork.
  3. Install horizontal piping as high as possible without sags or humps so that proper grades can be maintained for drainage. Pitch piping in direction of oil return to compressor.

4. Check all piping for interference with other trades, avoid placing water pipes over electrical equipment.
  5. Where rough-in is required for equipment furnished by others, verify exact rough-in dimension with owner or equipment supplier before roughing-in.
  6. Where refrigeration piping is buried, encase piping and insulation loosely in schedule 40 PVC and ventilate PVC pipe to allow vapor line to see outside air temperature. Ensure PVC pipe is free draining to prevent water buildup. Provide a riser trap and slope refrigeration line to trap. Where buried lengths exceed 25', provide a 90 minute timer wired parallel with thermostat control to operate unit every 90 minutes to maintain safe slugging levels.
- C. Valves
1. Refer to Section 23 05 23 - General Duty Valves for HVAC Piping.
  2. Locate valves for easy access and operation. Do not locate valves with stems below horizontal.
- D. Piping Specialties: Refer to Section 23 05 00 - Common Work Results for HVAC.
- E. Supports, Anchors and Seals: Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping.
- F. Install specialties and accessories as indicated on drawings and in accordance with manufacturer's recommendations and applicable codes and standards.
- G. Equipment Connections
1. General: Connect refrigerant piping system to refrigerant equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated.
- H. Field Quality Control
1. Refrigerant Piping Leak Test: Prior to initial operation, test refrigerant piping with electronic leak detector. System must be entirely leak free.
  2. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

**END OF SECTION 23 23 00**

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## SECTION 23 31 13 - METAL DUCTS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to fabricate and erect ductwork as required by the drawings and this section.
- B. Low velocity ductwork shall apply to the following:
  - 1. Supply: Downstream of terminal units.
  - 2. Return: Upstream of terminal units.
  - 3. Exhaust: Upstream of terminal units.
  - 4. Transfer & Combustion: Less than 1" static pressure.
  - 5. Outdoor & Relief: Upstream/Downstream of unit.
- C. High velocity ductwork shall apply to the following:
  - 1. Supply & Ventilation: Upstream of terminal units or velocity  $\geq$  than 2,000 FPM.
  - 2. Return: Downstream of terminal units and/or  $\geq$  than 2,000 FPM.
  - 3. Exhaust: Downstream of terminal units and/or  $\geq$  than 2,000 FPM.

#### 1.3 DEFINITIONS

- A. Conditioned Space: An area inside the building which is heated and/or cooled.
- B. Tempered Space: an area inside the building which is not directly heated or cooled, but is adjacent to a heated or cooled space with no insulation separating the two spaces (e.g., ceiling plenums).
- C. Untempered Space: an area inside the building which is not conditioned and is not tempered (e.g., attic spaces).
- D. Exterior: An area outside the building (e.g., roof mounted items).

#### 1.4 QUALITY ASSURANCE

- A. Duct and plenum construction, metal gauges, reinforcing, methods of supporting and hanging and other sheet metal work as called for shall be in accordance with the following standards:
  - 1. "SMACNA HVAC Duct Construction Standards", most recent Edition, by the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- B. Unless noted otherwise, all ductwork shall be provided with pressure class and leakage class as indicated and scheduled on the plans. If pressure or seal class is not indicated, ductwork shall be provided to meet the pressure class based on the scheduled capacity of the equipment it is served by or connected to and with seal class A.

- C. NFPA Compliance: All liner and covering materials shall have maximum UL Flame Spread Index of 25, and maximum Smoke Developed Index of 50, and shall meet all requirements of NFPA 90A.

## **1.5 SUBMITTALS**

- A. Shop Drawings:
  - 1. Submit ¼" per foot scale shop fabrication shop drawings.
    - a. Shop drawings shall include locations of all control devices, including dampers, airflow measuring stations, sensors, etc. Coordinate locations with the BAS Contractor prior to submitting shop drawings. Shop drawings shall include the BAS Contractor's submittal review stamp prior to submitting to the Design Professional for review.
  - 2. Submit shop drawings of elbows and fittings showing static pressure loss charted for air quantities involved in each.
- B. Two copies of duct leak testing results.
- C. Submit weld sample, welding information, and welders' certification for weld stainless steel ductwork. Submittal to include the following information:
  - 1. Welder name(s):
  - 2. Certification:
  - 3. Metal type and gauge:
  - 4. Joint preparation:
  - 5. Welding process:
  - 6. Equipment utilized:
  - 7. Filler specifications:
  - 8. Shield gas:
- D. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each mechanical system requiring insulation. Submit product data for each accessory/component for ducts/fittings including, but not limited to turning vanes, tie rods, sealants and balancing dampers.
- E. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data in maintenance manual.
- F. Certifications: Submit certifications or other data 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.
- G. Duct Leakage Test Results.

## **1.6 REGULATORY REQUIREMENTS**

- A. National Fire Protection Association, NFPA 90A: Air Conditioning and Ventilating Systems.
- B. Underwriter's Laboratories, UL 181: Factory-Made Duct Materials and Air Duct Connections.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Protect shop-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling.
  - 1. Stored materials subject to rejection due to damage.
- B. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of products.
- C. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged insulation; remove from project site.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. All sheet metal work shall be constructed of prime quality re-squared tight coat galvanized steel, except where other type material is specified. Manufacturer's name and U.S. gauge number shall appear on each sheet.
- B. Duct Lining Materials
  - 1. Certain Teed
  - 2. Owens Corning Fiberglass
  - 3. Johns Manville
  - 4. PPG
  - 5. Knauf
  - 6. Armacell

### **2.2 LOW VELOCITY DUCTWORK**

- A. General: Provide factory fabricated or shop fabricated duct and fittings.
- B. Materials:
  - 1. Galvanized sheet steel complying with ANSI/ASTM A527, lockforming quality, with ANSI/ASTM A525, G90 zinc coatings, mill phosphatized.
  - 2. Aluminum sheet complying with ASTM B 209 Alloy 3003, H14 temper with mill finish. Where ductwork is exposed and not designated to be painted, provide one-side bright finish.
- C. Gauge: Comply with code requirements for minimum gauge thickness for various sizes.
- D. Fittings:
  - 1. Construct branches, bends, and elbows with centerline radius of not less than duct 1.0 times the width (diameter), where space conditions will not permit this radius or where indicated on drawings, square elbows with air turns shall be used.
  - 2. Slopes for transitions or other changes in dimension shall be minimum 1:3.
  - 3. Longitudinal seams shall be Pittsburgh Lock or snaplock equal per SMACNA. Lateral seams shall be slip drive or standing. Slip seams and sheet metal screws not permitted.

**2.3 GALVANIZED STEEL DUCTWORK – HIGH VELOCITY**

A. Single-Wall Ducts: Spiral-wound, zinc-coated steel with individual formed steel tees and elbows.

1. Single-Wall Round Duct Gauges:

<u>Minimum USS Gauge Duct Diameter (Inches)</u>	<u>Spiral Lock Seam</u>
Up to 8	26
9 to 22	24
23 to 36	22
37 to 50	20
51 to 60	18
61 and Over	16

B. Access Panels: Shall be of same material as ducts in which they are installed, fabricated of two thicknesses of not less than 24 gauge, with 1" thick rigid glass fiber filler. Provide sheet metal frame, airtight gasket equal to United McGill AOBXFDDC.

C. Fabrication

- 1. Directional Change:
  - a. Construct tees, bends, and elbows with radius minimum 1.0 times width of duct on center line.
- 2. Size Change:
  - a. Increase and decrease duct sizes gradually, not exceeding 15%, unless otherwise noted on Drawings.
- 3. Seams and Joints: In accordance with SMACNA standards.
  - a. Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so not to breathe, rattle, vibrate or sag.
  - b. Where spiral ductwork is exposed, assemble duct to duct joints with spiral seam following continuous helicoid pattern across joints.

**2.4 PLENUMS**

A. Plenums shall be fabricated of same material as duct connecting to plenum; shall be two metal gauges heavier than gauge of largest duct connecting to plenum.

**2.5 DUCT SEALING – LOW VELOCITY**

A. All joints in low velocity duct work shall be sealed with Foster 32 14 or DuctMate ProSeal. Apply and install joint sealer per manufacturer’s recommendations. In general, apply to male end of coupling and/or interior of female fitting. After connection, brush sealant over the assembled joint and screws with a 2” to 3” wide band. Sealant shall be allowed to set for 48 hours before any air pressure is put on system. All tie bars, bolts and rivets shall be sealed with the specified sealant. Sealant as manufactured by 3M No. 800 or United Sheet Metal will be considered equal.

B. Duct Sealing Requirements: SMACNA Seal Class A.

## **2.6 DUCT SEALING - HIGH VELOCITY**

- A. All joints in high velocity duct work shall be sealed with Foster 32 14 or Ductmate ProSeal. Apply and install joint sealer per manufacturer's recommendations. In general, apply to male end of coupling and/or interior of female fitting. After connection, brush sealant over the assembled joint and screws with a 2" to 3" wide band. Sealant shall be allowed to set for 48 hours before any air pressure is put on system. All tie bars, bolts and rivets shall be sealed with the specified sealant. Sealant as manufactured by Minnesota Mining No. 800 or United Sheet Metal will be considered equal.
- B. Duct Sealing Requirements: SMACNA Seal Class A.

## **2.7 DUCT LINER**

- A. Lining materials shall be Type 'A' Duct Liner, Certain Teed Toughgard or equivalent, one and one half (1 1/2) pounds per cubic foot density or equal.
- B. Unless specifically indicated to not be insulated, all ductwork and accessories shall be either lined or wrapped. Duct systems not listed or without a type or thickness indicated on the plans shall be insulated with 1-1/2" wrap.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Assemble and install ductwork in accordance with recognized industry practices which will achieve airtight and quiet systems, capable of performing each indicated service.
  - 1. Install each run with minimum joints.
  - 2. Align ductwork accurately at connections and with internal surfaces smooth.
  - 3. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and prevent buckling and vibration.
- B. Ducts shall be installed following essentially lines indicated on drawings, install offsets, angles and transitions as may be required to avoid interferences with other work. Maintain full capacity of ducts at offsets, angles and transitions except where drawings indicate use of reducing or increasing transitions.
  - 1. General: Each duct section shall be rigidly supported from structure. Attach hangers to structure with expansion plugs, concrete inserts, beam clamps or other approved means. Rubber in shear isolators shall be installed in hangers for all ducts in equipment rooms, to prevent vibration transmission to the structure.
- C. Install hangers and supports in accordance with SMACNA Standards general locations:
  - 1. Install hangers close to transverse joints of main ducts and branches, clinch collar branch connections and the first branch elbows after nested splits.
  - 2. Locate hangers of duct penetrating walls or partitions as though the walls will contribute no support to the duct.
  - 3. Install hangers in pairs on exact opposite sides of duct.
  - 4. Maintain hanger spacing intervals less than, equal to, but not greater than the specified maximums.

5. Install hangers at the midpoint of small and medium size horizontal vaned square elbows. On wide vaned square elbows, install additional hangers at maximum allowable intervals or less measured along the heel lines of the elbows.
  6. Provide a set of hangers at the midpoint of small and medium size horizontal radius elbows. Install one or more supplementary hangers, as necessary, along the inside and outside arcs of large radius elbows of any angle whenever the lengths of these arcs exceed the maximum hanger spacing length for that particular size duct.
  7. Provide at least one set of hangers for short duct branches 3 feet or less in length.
  8. Provide each duct riser with a minimum of two supports completely spanning the shaft opening at each floor. One pair of supports may be used to support more than one duct riser, provided that the strength of the supports is increased appropriately and proper additional supplementary steel is used at the extra risers.
  9. Support duct risers, located between floors that are more than 15 feet high, at each floor and halfway points between floors. The distance between intermediate supports on very high floors should not exceed 12 feet. Intermediate hangers may be supported from an adjacent wall or hung by rods from supports on the floor above.
  10. Provide one or more sets of hangers for equipment in duct runs such as heating coils, etc., as recommended by their manufacturers.
  11. Hangers shall not be attached to metal roof deck.
- D. Locate duct hangers approximately:
1. 2 to 24 inches from flexible connections of fans.
  2. 2 to 24 inches from the outlets or flexible connects of VAV control units.
  3. 12 to 36 inches from the main duct to the first hanger of long branch ducts.
  4. 2 to 12 inches from the ends of all branch ducts and linear diffuser plenums.
  5. 2 to 24 inches from fire damper breakaway joints.
  6. 0 inches to half the duct width plus 2 inches from the vertical centerline of the lower elbow of short vertical offsets made with vaned square elbows. The width refers to the dimension of the elbow in the plane of the turn.
  7. 0 inches to half the duct width plus 2 inches from the vertical centerline of the bottom and top elbows of vaned square elbow offsets over 8 feet high.
  8. One eighth of the arc in from the ends of bottom and top radius elbows of vertical offsets longer than 8 feet. Short vertical offsets require hangers at the bottom elbow. Likewise, sloping offsets need at least one set of hangers at their lower radius elbow.
  9. 6 to 12 inches from transverse joints of ducts whose lengths are the same as specified hanger intervals.
  10. 6 to 12 inches from one side of walls or partitions penetrated by ducts.
- E. Maximum permitted hanger spacing:
1. Ducts with areas up to 4 square feet may have their hangers spaced up to 8 feet apart.
  2. Ducts with areas 4.1 to 10 square feet may have their hangers spaced not more than 6 feet apart.
  3. Ducts with areas over 10 square feet may have their hangers located up to 4 feet apart.
- F. Provide and install locking manual volume dampers in all duct systems as required for controlling air volumes to trunk ducts, branch ducts, outlets and inlets. Provide and install additional volume dampers as required by Testing and Balancing Contractor for balancing of system.
- G. All connections shall be sealed, including but not limited to branch connections, spin-ins, taps, access doors, access panels and connections to equipment. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.

- H. Duct sizes shown on drawings are net inside dimensions and sheet metal size shall be increased to allow for duct linings.
- I. Install as indicated on the drawings all duct mounted equipment as specified in other sections.
- J. Install eccentric reducers with tops of both duct sizes flush to maintain maximum ceiling space below ducts.
- K. Openings:
  - 1. Provide in ductwork to accommodate access doors, temperature control components and fire dampers.
  - 2. Install access panels for inspection and servicing of all duct mounted equipment including, but not limited to: reheat coils, sound attenuators, motorized dampers, airflow measuring stations, smoke and fire dampers.
  - 3. Provide pitot tube openings for testing of systems, complete with metal cap, with spring device or screw to ensure against air leakage.
  - 4. Where openings are provided in insulated ductwork, install insulation materials inside metal collar.
- L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- M. Connections:
  - 1. Connect duct to equipment with flexible fabric, sheet metal clips, screws and washers.
  - 2. At each point where ducts pass through partitions, provide sleeve with space between duct and sleeve packed with insulation and sealed.
- N. Where ducts pass through fire-rated walls, partitions, floors, and ceilings, seal openings in accordance with Specification Section 23 0500 - Common Work Results for HVAC.

### **3.2 DUCT LINER APPLICATION**

- A. Apply duct liner with coated or surface designed to be exposed facing the air stream and adhered with 100% coverage of fire retardant adhesive. When width exceeds 12" or height exceeds 24", additionally secure liner with mechanical fasteners spaced 12" maximum centers. Fasteners shall start within 3" of leading edge of traverse joints. Coat all exposed joints and edges of traverse joints with a fire retardant adhesive.
- B. Duct sizes shown on drawings are net inside dimensions and sheet metal size shall be increased to allow for duct lining.

### **3.3 ADJUSTING AND CLEANING**

- A. Cleaning:
  - 1. Clean ductwork internally, as it is installed, of dust and debris.
  - 2. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or where ductwork is to be painted.

B. Temporary Closure:

- At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation or that are on-site but not yet installed, provide temporary closure of polyethylene film or other covering until time connections are to be completed.

**3.4 DUCT LEAK TESTING – HIGH VELOCITY**

A. HVAC Supply and Exhaust Ducts:

- The system shall be leak tested at the design operating pressure with a total leakage not to exceed the requirements of SMACNA HVAC Systems Duct Design Chapter 5. The following guidelines shall be used:

<u>Duct Type</u>	<u>Unit Discharge Pressure (in. w.g.)</u>	<u>Leakage Class</u>	<u>Allowed Leakage CFM/100 sq. ft.</u>
Rectangular	< 3	6	12.5
Rectangular	≥ 3, ≤ 4	6	15
Rectangular	> 4	6	18
Round	< 3	3	6
Round	≥ 3, ≤ 4	3	7.5
Round	> 4	3	9.5

- For determining the allowed leakage for system, calculate the ductwork surface area and multiply by the listed CFM/100 sq. ft, for each test section and sum values for all sections making up the complete system.
- Carefully seal off all openings (except one for connecting the test equipment) to the riser or run-out section to be tested.
- Follow the recommendations of the manufacturer of the duct seal to allow for adequate cure time for sealer.
- Connect test blower, calibrated orifice tube and manometers to the system in accordance with the test equipment manufacturer's recommendations.
- When the specified test pressure is reached, allow the blower to run for one minute to make sure that the pressure is stabilized.
- When the pressure is holding steady, measure the air flowing through the orifice tube assembly.
- 20% of all High Velocity Supply and Exhaust ducts shall be tested as directed by the Design Professional. Additional portions of the duct systems may be required to be tested depending on the results of the initial Leakage Testing results and at the discretion of the Design Professional.
- Refer to schedule on plans for duct pressure and seal class requirements for various systems.

**3.5 DUCTWORK APPLICATION SCHEDULE – LOW VELOCITY**

<u>AIR SYSTEM</u>	<u>MATERIAL</u>
HVAC Supply, Return General Exhaust Transfer Vehicle Exhaust	Steel, Galvanized
Locker Room with Showers Exhaust	Aluminum



**3.6 DUCTWORK APPLICATION SCHEDULE – HIGH VELOCITY**

<u>AIR SYSTEM</u>	<u>MATERIAL</u>
HVAC Supply, Return, and General Exhaust	Steel, Galvanized

**END OF SECTION 23 31 13**

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## SECTION 23 33 00 - AIR DUCT ACCESSORIES

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of duct accessories is indicated on drawings and by the requirements of this section.
- B. Types of duct accessories required for project include the following:
  - 1. Fire and Smoke Dampers
  - 2. Volume Dampers/Regulators
  - 3. Flexible Ducts
  - 4. Access Doors
  - 5. Control Dampers
  - 6. Bar Frame – Security Product
  - 7. Relief Hoods

#### 1.3 QUALITY ASSURANCE

- A. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) "Fire Damper and Heat Stop Guide".
- B. Industry Standards: Comply with American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of duct accessories, except as otherwise indicated.
- C. UL Compliance: Construct, test, and label fire dampers in accordance with Underwriters Laboratories (UL) Standard 555 "Fire Dampers and Ceiling Dampers".
- D. NFPA Compliance: Comply with applicable provisions of ANSI/NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of duct accessories.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical information for each type of duct accessory, including dimensions, capacities, materials of construction, installation instructions, interfacing requirements with ductwork, and method of fastening or support where applicable.
- B. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory; include this data in Maintenance Manual.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products manufactured by one of the following:
  - 1. Flexible Ductwork

- a. Semco
  - b. Wiremold
  - c. Thermaflex
  - d. Valuflex
2. Flexible Ductwork – High Velocity
- a. Flexmaster: Type 3
  - b. Genflex: IHPL (1-1/2” thick insulation)
  - c. Thermaflex: M-KC (1-1/2” thick insulation)
3. Fire Dampers and Smoke Dampers
- a. Air Balance, Inc.
  - b. Pottorff
  - c. Ruskin Manufacturing Co.
  - d. Leader Industries
  - e. Greenheck
  - f. Safe-air / Dowco
  - g. Louvers & Dampers
  - h. United Enertech
  - i. Anemostat
4. Hinged Walk-In Access Doors:
- a. Ruskin
  - b. United Enertech
  - c. Kees
5. Bar Frame Security Product:
- a. Titus
  - b. Price
  - c. Carnes
  - d. Metal Aire
  - e. Krueger
  - f. Nailor
6. Relief Hood:
- a. Greenheck
  - b. Carnes
  - c. Ammerman
  - d. Acme
  - e. Vent Products
  - f. Jenn-Air
  - g. Penn

## 2.2 FIRE AND SMOKE DAMPERS

### A. General

- 1. Refer to 23 31 13 Metal Ducts for Low Velocity and High Velocity ductwork classifications.
- 2. In general, fire dampers, smoke dampers, and combination fire/smoke dampers are to consist of galvanized steel frame and blade construction, 165 degrees F. release temperature, and 1.5 hour UL 555 rating. Any locations requiring stainless steel construction, 212 degree F release temperature, or 3 hour UL 555 rating are identified on the drawings.
- 3. Provide all fire, smoke, and combination fire/smoke dampers as Factory Mutual Approvals as Specification Tested Product.

## B. Fire Dampers

1. Low Velocity Ductwork: Curtain type or low profile, single blade style dynamic fire dampers shall have a fire rating of 1.5 hours. Damper frame and blades shall be galvanized steel in gauges required by UL listing R-5531. Provide fusible link rated at 165 degrees F; link shall be labeled for use in dynamic systems. Dampers shall be rated for dynamic closure up to 2,000 fpm and 4" wg.
  - a. Curtain type duct mounted fire dampers to be Style B for rectangular ductwork and Style CR/CO for round and oval ductwork such that damper curtain is located outside of airstream. Closure spring dampers shall be stainless steel and shall be constant force type. Ruskin DIBD2 or equal.
  - b. Single blade style duct mounted fire dampers to have stainless steel bearings, permanently lubricated sleeve type turning in an extruded hole in the frame. Ruskin DFD-LP or equal.
  - c. Round fire damper to be Ruskin FDR25 or equal, 20 gage galvanized steel frame/sleeve with single skin 14 gage blades and stainless steel sleeve bearings.
  - d. Where 3-hour rated walls are indicated, fire damper shall be 3 hour UL555 Rated (Ruskin DIBD23 or equal).
2. Low Velocity Ductwork: Multiple blade dynamic fire dampers shall have a fire rating of 1.5 hours. Damper frame shall be constructed of 16 gage galvanized steel and damper blades shall be single skin 16 gage thickness. Bearings shall be stainless steel, permanently lubricated sleeve type turning in an extruded hole in the frame. Provide fusible link rated at 165 degrees F. Dampers shall be approved for vertical or horizontal mounting and shall be labeled for use in dynamic systems up to 2,000 fpm and 4" w.g. Ruskin DFD35 or equal.
  - a. Where 3-hour rated walls are indicated, fire damper shall be 3 hour UL555 Rated (Ruskin DFD60-3 or equal).
3. High Velocity Ductwork: Multiple blade dynamic fire dampers shall have a fire rating of 1.5 hours. Damper frame shall be constructed of 16 gage galvanized steel and damper blades shall be single piece airfoil shaped with 14 gage equivalent thickness. Bearings shall be stainless steel, permanently lubricated sleeve type turning in an extruded hole in the frame. Provide fusible link rated at 165 degrees F. Dampers shall be approved for vertical or horizontal mounting and shall be labeled for use in dynamic systems up to 4,000 fpm and 4" w.g. Ruskin DFD60 or equal.
  - a. Where 3-hour rated walls are indicated, fire damper shall be 3 hour UL555 Rated (Ruskin DFD60-3 or equal).

## C. Smoke Dampers

1. Frame shall be a minimum of 16 gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber mechanically locked to blade. Jamb seal shall be stainless steel flexible metal compression type.
  - a. For low velocity ductwork, blades to be v-grooved type, 16 gage minimum galvanized steel. Basis of Design: Ruskin SSD 36.
  - b. For high velocity ductwork, blades to be airfoil type, 14 gage minimum galvanized steel. Basis of Design: Ruskin SD 60.

2. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable.
  - a. For low velocity ductwork, leakage rating under UL 555S shall be leakage Class II. As part of the UL qualification, dampers shall have demonstrated a capacity to operation (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. in the closed position and 2,000 FPM air velocity in the open position.
  - b. For high velocity ductwork, leakage rating under UL 555S shall be leakage Class I. As part of the UL qualification, dampers shall have demonstrated a capacity to operation (to open and close) under HVAC system operating conditions, with pressures of at least 8" w.g. in the closed position and 4,000 FPM air velocity in the open position.
  - c. Where 3-hour rated walls are indicated, combination fire/smoke damper shall be 3 hour UL555 Rated, UL555S Leakage Class I (Ruskin SD60-3 or equal).
3. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250 deg. F or 350 deg. F, depending upon the actuator. Electric actuators (120V two position) shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL555S qualifications for both dampers and actuators. Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 84" wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. All wiring or piping material required to interconnect the actuator with detection and/or alarm or other systems shall be provided by Division 28.
  - a. EP switches shall be provided and installed by Temperature Control Contractor for connection to the Fire Alarm System. See Section 23 0900 - Building Automation System (BAS).
  - b. Damper actuator motors to be Belimo.

\*2.05

4. Blade position Indicator: Each smoke damper shall be equipped with Ruskin SP100 Switch Package or equal.
  - a. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

#### D. Combination Fire/Smoke Dampers

1. Frame shall be a minimum of 16 gage galvanized steel formed into a structural hat channel reinforced at corners. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Galvanized bearings are not acceptable. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge (adhesive or clip fastened seals not acceptable). Jamb seals shall be non-corrosive stainless steel flexible metal compression type to further ensure smoke management.
  - a. For low velocity ductwork, blades to be v-grooved type, 16 gage minimum galvanized steel. Basis of Design: Ruskin FSD 36.
  - b. For high velocity ductwork, blades to be airfoil type, 14 gage minimum galvanized steel. Basis of Design: Ruskin FSD 60.

2. Unless specifically noted otherwise, each combination fire/smoke damper shall be classified for use for fire resistance ratings of less than 3 hours, in accordance with UL standard 555, and shall further be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems in accordance with the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers, required by this specification. Testing and UL qualifying a single damper size is not acceptable.
  - a. For low velocity ductwork, leakage rating under UL 555S shall be leakage Class II. As part of the UL qualification, dampers shall have demonstrated a capacity to operation (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. in the closed position and 2,000 FPM air velocity in the open position.
  - b. For high velocity ductwork, leakage rating under UL 555S shall be leakage Class I. As part of the UL qualification, dampers shall have demonstrated a capacity to operation (to open and close) under HVAC system operating conditions, with pressures of at least 8" w.g. in the closed position and 4,000 FPM air velocity in the open position.
  - c. Where 3-hour rated walls are indicated, combination fire/smoke damper shall be 3 hour UL555 Rated, UL555S Leakage Class I (Ruskin FSD60-3 or equal).
3. In addition to the leakage ratings already specified herein, the dampers and their actuators shall be qualified under UL555S to an elevated temperature of 350 deg. F. Appropriate 120V electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Manufacturer shall provide factory assembled sleeve of 17" minimum length (contractor to verify requirement). Factory supplied caulked sleeve shall be 20 gage for dampers through 84" wide and 18 gage above 84" wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. All wiring or piping material required to interconnect the actuator with detection and/or alarm or other systems shall be provided by Division 28.
  - a. EP switches shall be provided and installed by Temperature Control Contractor for connection to the Fire Alarm System. See Section 23 0900 - Building Automation System (BAS).
  - b. Damper actuator motors to be Belimo.

\*2.05

4. Each combination fire/smoke damper shall become equipped with a controlled 7 to 15 second heat-actuated release device. The device shall close and lock the fire/smoke damper during test, smoke detection, power failure or fire conditions through actuator closure springs. To prevent duct and HVAC component damage, the damper shall at all times be connected to the actuator for controlled closure in not less than 7 seconds and no more than 15 seconds. Instantaneous damper closure is unacceptable. Damper shall be automatic resettable after test, smoke detection or power failure conditions. After exposure to high temperature or fire, the damper must be inspected prior to reset to ensure proper operation. Release temperatures are 165 deg. F.
5. Blade Position Indicator: Each damper shall be equipped with Ruskin SP100 Switch Package or equal.
  - a. The Switch Package shall include two position indicator switches linked directly to the damper blade to provide the capability of remotely indicating damper blade position.

## 2.3

### 2.3 HINGED WALK-IN ACCESS DOORS

#### A. Hinged Walk-in Access Doors

1. Walk-In Access Doors shall be constructed of same material as ductwork/plenum they are installed in, 24 gauge minimum with double wall construction and minimum 1-1/2" thick rigid insulation and 10"x10" (minimum) double pane viewing window. Provide sheet metal frame with air tight gasket, hinges, latches and pull handle. Provide minimum 2"x2" tube frame around full perimeter of door. Refer to plans for door size and hinge location. Ruskin Sound Control door or equal.
2. Install hinged walk-in access doors plumb and level in duct/plenum at locations and with orientations indicated on the plans. Doors shall swing in when installed in positively pressurized ducts/plenums and out when installed in negatively pressurized ducts/plenums. Seal door frame airtight to the duct/plenum.

## 2.4 MISCELLANEOUS

#### A. Manual Volume Dampers:

1. Rectangular duct width of 48" or smaller and height of 12" or smaller or all round ducts.
  - a. Damper shall be fabricated of same material as the duct, two metal gauges heavier than duct and hammered 1" all around.
  - b. Provide end bearings with gasket. Models listed are Young Regulator Co. Equals by Elgin are acceptable
    - 1) Round ducts 4" to 8" with 3/8" rod: Model 666-RD.
    - 2) Round ducts greater than 8" and all rectangular ducts with 3/8" rod: Model 666-FD.
    - 3) All round and rectangular ducts with 1/2" rod: Model 515A.
  - c. Blades and rods construction:
    - 1) Rectangular duct width of 12" or smaller: Damper blade shall be mounted on two 3/8" pins on the ends of the blade.
    - 2) Rectangular duct width greater than 12": Damper blade shall be mounted on continuous 1/2" rod.
    - 3) Round duct of 12" diameter or smaller: Damper blade shall be mounted on two 3/8" pins on the ends of the blade.
    - 4) Round duct diameters larger than 12": Damper blade shall be mounted on a continuous 1/2" rod.
2. All other rectangular duct that fall outside the criteria above shall be opposed action multi-blade.
  - a. Damper frames are to be constructed of minimum 13-gauge.
  - b. Damper blade width shall not exceed 9 inches and the blade length shall not exceed 48 inches. Damper blades shall be of corrugated type construction.
  - c. Damper shall be constructed of the same material as the duct in which it will be installed.
  - d. Where damper shafts penetrate the damper housing, it shall be sealed while allowing the free movement of the shaft without breaking the seal.
  - e. Provide with shaft extension where duct will have exterior insulation applied.

#### B. Manual Volume Damper Regulators:

1. Accessible areas: Provide locking position regulator with gasket and handle. Below model numbers are based on Young Regulator Co. Equals by Elgin are acceptable.
  - a. Model 403 for a 3/8" damper shaft on ductwork without external insulation.



- b. Model 443B for a 3/8" damper shaft on ductwork with external insulation.
  - c. Model 404 for a 1/2" damper shaft on ductwork without external insulation.
  - d. Model 404B for a 1/2" damper shaft on ductwork with external insulation.
2. Inaccessible areas: Provide concealed manual volume damper regulators with BCW casing and wire and rack and pinion assembly. Damper shall be able to be operated when the damper and rack and pinion assembly are up to 50 ft apart. Young Regulator Co. Model 270-275 or equal by Elgin. Provide minimum 6" tag for each damper for identification.
- C. Backdraft Dampers
- 1. Counter-balanced backdraft damper Ruskin model CBD6 or equal.
    - a. Frame: Heavy duty 0.125" thick aluminum
    - b. Blades: 0.070 thick aluminum with extruded vinyl edge seals
    - c. Bearings: Zytel
    - d. Linkage: 0.125" thick aluminum tie bars
    - e. Counterbalance: Zinc plated bar mounted on blades with adjustability for job site final setting
    - f. Temperature: -40 deg F to 200 deg F
    - g. Back Pressure:
      - 1) 48" section width – up to 4" wc
      - 2) 36" section width – up to 8" wc
      - 3) 24" section width – up to 12" wc
      - 4) 12" section width – up to 16" wc
    - h. Operation: blades start to open at 0.01" wc and are fully open at 0.05" wc
- D. Air Turns: Elgen "Air Tite" or equal shop fabricated.
- E. Access Panels: Shall be of same material as ducts in which they are installed, fabricated of two thicknesses of not less than 24 gauge, with 1" thick rigid glass fiber filler. Provide sheet metal frame, air tight gasket and two thumb operated cam lock latches. Latches must be operable without the use of any tools.
- F. Motorized Outside Air Dampers:
- 1. Low leakage type. AMCA certified.
  - 2. Outdoor air and exhaust air dampers shall be insulated (thermally broken) type.
  - 3. Damper Blades
    - a. Steel or aluminum airfoil type with mechanically locked blade seals, 8 inch 200 mm blade width maximum measured perpendicular to axis of damper.
    - b. Jamb seals shall be flexible metal compression type.
    - c. Opposed or single blade type.
  - 4. Make provision of damper actuators and actuator linkages to be mounted external of airflow.
- G. Damper Actuators:
- 1. Electric type equipped for Class 1 wiring.
  - 2. Shall not consume power during UNOCCUPIED cycle or use chemicals or expandable media.
  - 3. Have built in spring return.

## **2.5 FLEXIBLE DUCT – LOW VELOCITY**

- A. Flexible duct shall be factory pre-insulated, consisting of vinyl coated spring steel wire helix bonded to vinyl coated fiberglass mesh screen, having one (1) inch nominal fiberglass insulation and vinyl impregnated closely woven fiberglass vapor barrier. Basis of Design: Semco, Type A1.
- B. Composite assembly shall meet Class I requirements of NFPA-90A and shall be UL listed for flame spread rating of not more than 25 and smoke developed rating of not more than 50. Assembly shall meet the requirements of UL-181.
- C. Where flexible duct is allowed, it shall be connected to metal ducts, terminal units and diffusers with Panduit, Tylon or equal tool installed nylon clamps.
- D. Maximum length of flexible duct connections from metal duct to terminal units and grilles, registers and diffusers shall be not greater than 72". All duct turns greater than 45 deg. shall be rigid elbows.
- E. Wherever ductwork is routed exposed, flexible ductwork is not acceptable. All exposed ductwork to be rigid.
- F. Flexible duct is not allowed at diffuser and grille connections within the detention area of the building. Rigid duct connections to diffusers and grilles is required.

## **2.6 FLEXIBLE DUCT – HIGH VELOCITY**

- A. Suitable for -20°F to 220°F temperature range and minimum 12 inches w.c. working pressure.
- B. Inner Liner: Glass fiber, PVC coating, factory-clinched in cold-rolled galvanized steel spiral, or with spiral wire permanently bonded to fabric, UL listed, complying with NFPA 90.
- C. Outer Jacket: 1-1/2" thick, 3/4 lb. fibrous glass, with flame-resistant PVC vapor barrier.

## **2.7 BAR FRAME – BARRIER WALL OPENING PROTECTION**

- A. Barrier wall opening in the detention area of the building require bars to protect the non-secure side of the wall from the secure side of the wall.
- B. Bar frame to be constructed of flat steel frame, flat horizontal steel bars on 6" centers and 3/4 inch diameter vertical steel bars on 6" centers.
- C. Bar frame to be Titus SG-BG-FM or equal.

## **2.8 RELIEF HOOD**

- A. Hoods shall be low silhouette type.
- B. Hoods shall be aluminum, all welded construction with mitered corners.
- C. Hoods shall be removable, cross broken, undercoated with insulating mastic and fabricated of aluminum alloy 3003-H14. Louver blades and extruded members shall be aluminum alloy 6063-T5.
- D. Relief hoods shall be furnished with 1/2", 19 ga galvanized steel bird screen and backdraft damper.

- E. Hoods shall be furnished with factory fabricated curbs and extended bases, as required for mounting with inlet/outlet minimum of 24" above roof.
- F. Curbs shall be galvanized steel or extruded aluminum with continuous welded corner seams, treated wood nailer, minimum 1-1/2" thick 3 lb/ft<sup>3</sup> density rigid mineral fiberboard insulation with metal liner.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine areas and conditions under which duct accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install access panels for inspection and servicing of all duct mounted equipment including, but not limited to: reheat coils, sound attenuators, motorized dampers, airflow measuring stations, fire dampers, smoke dampers, and combination fire/smoke dampers. Unless noted otherwise, access doors to be square and dimensions shall be 2" less than the duct dimension where they are installed, with a maximum size requirement of 24" x 24". Locate access doors (i.e. side or bottom of duct) where they provide the best access to duct equipment/accessory relative to surrounding piping, equipment, structure, etc.
- C. Access doors for fire dampers, smoke dampers, and combination fire/smoke dampers shall be a minimum of 12" x 12". Where maximum duct dimension (height or width) is less than 12", provide a square access door with dimensions 2" less than the duct dimension where door is installed; also, a removable section of ductwork shall be provided at the damper connection to allow for access to the damper. Removable section of ductwork shall be 24" in length and have flanged connections on both ends (or may be an elbow fitting if immediately downstream of damper).
- D. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- E. Install all fire, smoke, and combination fire/smoke dampers in accordance with manufacturer's installation instructions for UL Listing.
- F. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.
- G. Field Quality Control: Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- H. Coordinate installation of smoke and combination fire/smoke damper switch package and indicating lights with Electrical Contractor. Switch package to be provided by HVAC Contractor.
- I. Furnish General Contractor with layout and size of wall openings. Coordinate installation of louver with General Contractor. Make duct connections to louvers as shown on the plans.

- J. Install all manual dampers with damper in full open position.

**END OF SECTION 23 33 00**

## SECTION 23 34 16 - HVAC FANS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of HVAC fan work is indicated on drawings and schedules, and by requirements of this section.
- B. Types of fans required for this project include the following:
  - 1. Utility Fans
  - 2. In-line Cabinet Fans
  - 3. In-line Centrifugal Fans
  - 4. Axial Fans
- C. Vibration isolation required for air distribution equipment is specified in other Division 23 sections, and is included as work of this section.
- D. Refer to section 23 05 13 Common Motor Requirements for HVAC Equipment for motor requirements furnished with HVAC fans.
- E. Refer to Division 26 sections for power work required in conjunction with air distribution equipment; not work of this section.

#### 1.3 QUALITY ASSURANCE

- A. AMCA Compliance: Provide HVAC fans bearing the Air Movement and Control Association, Inc. (AMCA) Certified Ratings Seal.
- B. UL Compliance: Provide air distribution equipment electrical components which have been listed and labeled by Underwriters Laboratories (UL).
- C. NFPA Compliance: Fan and fan installation shall be compliant with applicable NFPA requirements.

#### 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver HVAC fans with factory installed shipping skids and lifting lugs; pack components in factory fabricated protective containers.
- B. Handle HVAC fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to fan manufacturer.
- C. Store HVAC fans in clean dry place and protect from weather and construction traffic.

## **1.5 SUBMITTALS**

- A. Submittal data shall include physical dimensions, fabrication details, materials, fan curves, sound ratings, motor size and electrical characteristics and required brake horsepower for specified operating conditions.

## **1.6 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Utility Fans
  - 1. Greenheck
  - 2. Carnes
  - 3. Penn Barry
  - 4. Loren Cook Co.
  - 5. Twin City Fan & Blower
  - 6. Acme
  - 7. Thermotek
  
- B. In-line Cabinet Fans
  - 1. Greenheck
  - 2. Carnes
  - 3. PennBarry
  - 4. Loren Cook Co.
  - 5. Twin City Fan & Blower
  - 6. Acme
  - 7. Thernotek
  
- C. In-Line Centrifugal Fans
  - 1. Greenheck
  - 2. Carnes
  - 3. PennBarry
  - 4. Loren Cook Co.
  - 5. Twin City Fan & Blower
  - 6. Acme
  - 7. Thermotek
  
- D. Vane Axial Fans
  - 1. Greenheck
  - 2. Carnes
  - 3. PennBarry

4. Loren Cook Co.
5. Twin City Fan and Blower
6. Acme
7. Thermotek

## **2.2 UTILITY FANS**

- A. General: Provide utility fans of sizes and arrangement as indicated, and of capacities and having accessories as scheduled.
- B. Ratings: Test and rate fans in accordance with ASHRAE Standard 51 (AMCA Standard 210). Provide fans bearing AMCA Certified Ratings Seal.
- C. Fan Units: Provide Factory assembled and tested fan units consisting of housing, wheel, fan shaft, bearings and fan drive. Clean, condition, and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.
- D. Housings: Construct of heavy gage steel with side sheets fastened to scroll sheets by means of deep lock seam. Provide round inlet collar, slip joint discharge duct connection. Construct housing to be convertible to 8 standard discharges. Provide adjustable motor supports.
- E. Wheels: Provide forward curved or backward inclined wheels as scheduled. Provide swaged hubs. Balance wheels statically and dynamically. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.
- F. Shafts: Construct of AISC C 1040 ground and polished steel. Apply rust preventive coating.
- G. Bearings: Provide self-aligning, grease lubricated, pillow block type bearings, selected for minimum average life (AFBMA L 50) of 200,000 hours.
- H. Motors: Provide open drip proof motors with ball or sleeve bearings. Provide split phase or capacitor start motors for fractional horsepower, with resilient base. Provide induction motors for integral horsepower, with rigid base.
- I. Drives: Provide V belt drives for fractional horsepower motors selected for 1.2 service factor. Provide V belt drives for integral horsepower motors selected for 1.4 service factor. Provide adjustable pitch sheave, selected for midpoint at design conditions.

## **2.3 IN-LINE CABINET FANS**

- A. General: Provide duct mounted supply, exhaust or return fans of the centrifugal, belt driven in-line type.
- B. Ratings: All fans shall bear the AMCA Certified Ratings Seal for air performance.
- C. Casing: The fan housing shall be of the rectangular design constructed of heavy gauge galvanized steel and shall include rectangular duct mounting collars. A hinged or removable panel shall be provided in the fan cabinet of sufficient size to permit access for service to all of the fan's internal components without dismantling the cabinet.
- D. Fan: The fan wheel shall be of the galvanized steel, forward curved, centrifugal type. Wheels shall be dynamically and statically balanced.

- E. Motor: Heavy duty type with permanently sealed ball bearings. The wheel shaft shall be ground and polished steel mounted in permanently sealed pillow block bearings.
- F. Drives: For belt drive units a drive shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulleys shall be adjustable for final system balancing.
- G. Accessories:
  - 1. Insulated Housing
  - 2. Disconnect switches
  - 3. Spring Vibration Isolators

#### **2.4 IN-LINE CENTRIFUGAL FANS**

- A. General: Provide fans of sizes and arrangement and capacities as indicated on schedule. Fans shall be tested and rated in accordance with ASHRAE Standard 51 (AMCA Standard 210). Fans shall bear the AMCA Certified Rating Seal for both sound and performance.
- B. Housing: Heavy duty galvanized steel with square duct mounting collars and removable access panels for ease of maintenance.
- C. Fan Wheel: Centrifugal backward inclined, aluminum, with wheel and inlet cones. Fan wheels shall be statically and dynamically balanced. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.
- D. Fan Shaft shall be solid AISI C1040 hot rolled steel, turned and polished. Close tolerances to be maintained where shaft makes contact with bearings.
- E. Bearings: Fans shall have precision, flange mounted, self-aligning ball bearings at inlet and discharge. Bearings are to be grease lubricated and selected for a minimum average life (AFBMA L 50) in excess of 200,000 hours at maximum cataloged operating conditions. Grease lines extend to exterior of fan housing.
- F. Motors: Provide open drip proof motors with ball or sleeve bearings. Provide split phase or capacitor start motors for fractional horsepower, with resilient base. Provide induction motors for integral horsepower, with rigid base.
- G. Drives: Provide V belt drives for integral horsepower motors selected for 1.4 service factor. Provide adjustable pitch sheave, selected for midpoint at design conditions.
- H. Provide NEMA 1 disconnect switch with built-in overload protection.
- I. Finish: All surfaces to have factory primed and painted. Exterior is to have an enamel finish.
- J. Accessories:
  - 1. Insulated Housing
  - 2. Disconnect Switches
  - 3. Spring Vibration Isolators
  - 4. Motor Cover
  - 5. Belt Cover
  - 6. Backdraft Damper



## **2.5 VANE AXIAL FANS**

- A. General: Provide fans of sizes and arrangement as indicated, and of capacities and having accessories as scheduled.
- B. Ratings: Test and rate fans in accordance with ASHRAE Standard 51 (AMCA Standard 210). Provide fans bearing AMCA Certified Ratings Seal.
- C. Fan Units: Provide Factory assembled and tested fan units consisting of housing, wheel, fan shaft, bearings and fan drive. Clean, condition, and prime paint sheet metal parts prior to final assembly. Apply final coat of enamel to exterior surfaces after assembly.
- D. Housing: Fans shall have housings of 14 gauge steel hydraulically expanded to form integral inlet bell and diffuser sections. Hydraulically expanded stiffening rings welded in area of wheel raceway. All sizes have outer frame for mounting and slip joint duct connections.
- E. Fan Wheel: Fans shall have fan wheel of precision aluminum casting with radially projected blades with airfoil cross sections. All wheels are to be dynamically balanced and keyed to fan shaft. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.
- F. Diffuser: Fans shall have a cast aluminum diffuser with radially projected straightening vanes with airfoil cross section.
- G. Fan Shaft shall be solid AISI C1040 hot rolled steel, turned and polished. Close tolerances to be maintained where shaft makes contact with bearings.
- H. Bearings: Fans shall have precision, flange mounted, self aligning ball bearings at inlet and discharge. Bearings are to be grease lubricated and selected for a minimum average life (AFBMA L 50) in excess of 200,000 hours at maximum cataloged operating conditions. Grease lines extend to exterior of fan housing.
- I. Motors: Provide open drip proof motors with ball or sleeve bearings. Provide split phase or capacitor start motors for fractional horsepower, with resilient base. Provide induction motors for integral horsepower, with rigid base.
- J. Drives: Provide V belt drives for integral horsepower motors selected for 1.4 service factor. Provide adjustable pitch sheave, selected for midpoint at design conditions.

## **PART 3 - EXECUTION**

### **3.1 INSPECTIONS**

- A. Examine areas and conditions under which fans are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION OF HVAC FANS**

- A. Install fans where indicated, in accordance with equipment manufacturer's installation instructions, and with recognized industry practices, to ensure that equipment complies with requirements and serves intended purposes.

- B. Coordinate with other work, including ductwork and electrical work as necessary to interface installation of HVAC fans with other work. Furnish layout and size of roof curbs for roof mounted fans and wall openings for wall mounted fans to General Contractor.
- C. Install units with vibration isolators or isolation bases, complying with Division 23, Section 23 0548 - Vibration Controls for HVAC Piping, ductwork and Equipment.
- D. Secure curb cap of roof mounted fans to wood nailer on roof curb within 3" of corners and 18" on center with nonferrous, cadmium plated or stainless steel lag screws using weather resistant gaskets to form a watertight connection.
- E. Alignment: Check alignment of belt driven fans, and, where necessary, realign shafts of motors and fans within recommended tolerances by manufacturer, and in presence of manufacturer's service representative

### **3.3 ELECTRICAL CONNECTIONS**

- A. Ensure HVAC fans are wired properly, with rotation in direction indicated and intended for proper performance.
- B. Provide positive electrical equipment and motor grounding.

### **3.4 FIELD QUALITY CONTROL**

- A. Upon completion of installation of HVAC fans, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.

### **3.5 BALANCING**

- A. Refer to Division 23, Section 23 05 93 - Testing, Adjusting and Balancing for HVAC of fan systems; not work of this section.

### **3.6 SPARE PARTS**

- A. General: Furnish to owner, with receipt, 1 spare set of belts for each belt driven equipment item.

**END OF SECTION 23 34 16**

## SECTION 23 36 00 - AIR TERMINAL UNITS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install air terminal units as required by the drawings and this section.

#### 1.3 TERMINAL UNITS

- A. Air Terminal units shall include the following:
  - 1. VAV Boxes

#### 1.4 SUBMITTALS

- A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the air terminal units.

#### 1.5 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. VAV Boxes
  - 1. Carnes
  - 2. Titus
  - 3. E.H. Price
  - 4. Metal Aire
  - 5. Krueger
  - 6. Nailor
  - 7. Tuttle & Bailey
  - 8. Johnson Controls

## 2.2 VAV BOXES

- A. General: Ceiling mounted variable air volume supply air for connection to single, medium pressure duct, central air systems, with heating coils (where scheduled) and air flow measuring station. Direct digital controls and actuation to be provided by DDC Controls Contractor.
- B. Casing: 22-gauge galvanized steel housing, mechanically sealed and gasketed. Provided with round stub inlet duct connection and S and drive outlet duct connection. Hanger holes to be provided on four corners for installation. Leak rate not greater than two percent at 0.5 inch wg. for sizes up through 14 inch and not greater than three percent for sizes 16 inch and above.
- C. Lining: Fiber free foam insulation system which complies with NFPA 90A and UL 181. Fiber free foam insulation thickness to be a minimum of 3/4" (R value = 3).
- D. Control Damper:
  - 1. Locate air volume damper assembly inside unit casing. Construct from extruded aluminum or 20 gauge galvanized steel components with peripheral gasket and solid steel shaft, pivoted in self-lubricating bearings.
  - 2. Air volume control damper shall be factory calibrated assembly consisting of damper and damper shaft extension for connection to externally mounted control actuator.
  - 3. Leakage rate not greater than 2% of nominal CFM at 1" 3 in. w.g. inlet static pressure when tested in accordance with ASHRAE 130.
- E. Air Flow Sensor: Eight point flow sensing ring capable of sensing true airflow to within +/- 10 percent regardless of inlet duct connection. Sensor includes pressure taps on inlet cone of air valve to provide the velocity signal for volume regulator and to measure airflow through the valve when used in conjunction with calibration chart provided on unit.
- F. Automatic Flow Controller: To be a thermostatically reset velocity controller which provides constant delivery air control within +/- 5 percent of rated flow down to 25 percent of unit rated cfm, independent of changes in system static pressure, with 1 1/2 diameters of straight duct at the unit inlet. Control to within +/- 10 percent to be obtained with any inlet duct connection. Factory calibrated, field adjustable setpoints shall be provided to set maximum and minimum cfm.
- G. Reheat Coils (where applicable for supply air units): Coils shall have capacities and ratings as scheduled on the drawings. Coils shall consist of seamless copper tubes mechanically bonded to aluminum fins. Maximum working pressure 125 psig and test pressure of 300 psig.
- H. Provide terminal unit with control enclosure.
- I. VAV terminal unit with hot water reheat coil coils shall include a factory installed coil access door upstream of the coil. Access door shall be lined with the same material installed in the case and shall have cam lock latches (latches must be operable without the need for any tools); screw fasteners and non-insulated doors are not acceptable. Access doors shall be a minimum of 4" x 6-1/2".

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install units and make duct and piping connection as indicated on drawings. Multi-row coils shall be installed in counterflow arrangement relative to airflow.

- B. Install shut off cocks, balancing cocks, air vents, control valves and devices as required for complete installation.
- C. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.
  - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start up until wiring installation is acceptable to equipment installer.

**END OF SECTION 23 36 00**

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## SECTION 23 37 13 - DIFFUSERS, REGISTERS AND GRILLES

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary for the installation of grilles, registers and diffusers as per the schedules on the drawings.

#### 1.3 SUBMITTALS

- A. Submit manufacturer's catalog cuts for each type of device to be used.
- B. Product Data: For each product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufacturers
  - 1. Carnes
  - 2. Titus
  - 3. Price
  - 4. Metal Aire
  - 5. Krueger
  - 6. Nailor
  - 7. Anemostat

- 2.2 Diffusers, registers, and grilles shall be of the type and style as scheduled.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install wall mounted grilles and registers plumb and level and flush to surface. Locations may be altered slightly, as acceptable to the Design Professional, so as to fit masonry portions of the structure.
- B. In grid panel type ceilings, lay in metal pan, acoustical, etc., grilles, registers and diffusers shall be located in the center of the panel.

- C. Coordinate locations of ceiling diffusers and registers with Design Professional's reflected ceiling plan. Where architectural features or other items conflict with installation, notify Design Professional for determination of final location.
- D. Adjust blow pattern as indicated on plans and as scheduled, prior to balancing.
- E. Diffusers and grilles installed within the detention area of the building to be installed to prevent tampering and removal from the room the diffusers and grilles serve.

**END OF SECTION 23 37 13**



## SECTION 23 51 00 - BREECHINGS, CHIMNEYS, AND STACKS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of breeching and smokepipe work is indicated on drawings, and by requirements of this section.
- B. Types of breeching and smokepipe required for project specified in this section, and listed on schedule located on drawings, include the following:
  - 1. Type B double wall gas vents.
  - 2. Positive pressure piping.
  - 3. Boiler breeching and stack.
  - 4. Engine exhaust.
  - 5. Double wall gas venting system with AL 29-4C alloy.
- C. Applications for breeching and smokepipe include the following:
  - 1. Flues from gas fired furnaces.
  - 2. Flues from gas fired water heaters.
  - 3. Flues from gas-fired boilers.
  - 4. Exhaust from internal combustion engines.
- D. Refer to Division 23 fuel burning equipment sections for draft hoods associated with atmospheric fuel burning equipment; not work of this section.

#### 1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with ANSI/NFPA 211 "Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances" for construction and installation requirements of breeching and smokepipe.
- B. UL Compliance and Labeling: Comply with applicable portions of UL safety standards pertaining to breeching and smokepipe; provide products which have been UL listed and labeled.
- C. Double wall gas venting system with AL 29-4C alloy shall be tested and listed by Underwriters Laboratories to UL 1738, the venting standard for positive pressure and condensing appliances. It shall also be tested and listed to portions of UL 441 and UL 103 for natural draft gas appliances.

#### 1.4 SUBMITTALS

- A. Shop Drawings: Submit shop fabrication shop drawings. Include shop drawings of elbows and fittings showing dimensional and performance data.
- B. Submit manufacture data on materials, fittings and joint construction, and installation for breeching and smokepipe.

**PART 2 - PRODUCTS**

**2.1 ACCEPTABLE MANUFACTURERS**

- A. Double Wall Gas Venting System
  - 1. Heat Fab, Inc.

**2.2 TYPE B DOUBLE WALL GAS VENTS**

- A. General: Provide double wall gas vents, UL listed for Type B, consisting of double wall metal construction pipe sections and fittings and accessories required for complete installation.
- B. Materials: Construct inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, both of the following minimum thickness:

<u>Size</u>	<u>Inner Pipe</u>	<u>Outer Pipe</u>
Round sizes up to 6"	0.012"	28 ga.
Round sizes 7" to 18"	0.014"	28 ga.

- C. Accessories: Provide manufacturer's standard accessory items as indicated, for complete installation.

**2.3 DOUBLE WALL GAS VENTING SYSTEM WITH AL 29-4C ALLOY**

- A. This factory-built chimney shall be laboratory tested and listed by the Underwriters Laboratories, Inc., for use with building heating equipment burning natural gas. The flue shall feature an inner liner wall of AL 29-4C a patented alloy of the Allegheny Ludlum Corp. tested to the corrosion requirements of UL 1738.
- B. The system shall feature a patented external locking ring and tab joining system which eliminates internal protruding, low-alloy fasteners that could corrode when in contact with acidic condensate. The ring and tab mechanism, together with 100% welded seams shall insure the integrity of the interior smooth-wall design, minimizing turbulence and flow resistance. There shall be no corrugation on straight pieces where condensation could collect. The system shall be pressure tight and listed for 1.5 inches of wc when installed with the factory-recommended sealant. The joining system shall require no drilling or special tools. The outer wall shall be to type 430 stainless steel to create an insulating air space of approximately 1/4" and provide added stability for free-standing applications.

**PART 3 - EXECUTION**

**3.1 INSTALLATION OF DOUBLE WALL GAS VENTING SYSTEM WITH AL 29-4C ALLOY**

- A. General: Install double wall gas venting system with AL 29-4C alloy in accordance with manufacturer's installation instructions. Maintain UL-listed minimum clearances from combustibles. Assemble pipe and accessories as indicated for complete installation.

**END OF SECTION 23 51 00**

## SECTION 23 52 16 - CONDENSING BOILERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of gas fired boiler work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of gas fired boiler specified in this section include the following:
  - 1. High efficiency modular gas fired boilers.
- C. Refer to other Division 23 sections for concrete pads, piping, specialties, pumps, breechings, etc., required external to boilers for installation; not work of this section.
- D. Refer to Division 26 sections for field installed power wiring required for gas fired boilers; not work of this section.

#### 1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. NFPA Compliance: Install gas fired boilers in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".
  - 2. ASME Compliance:
    - a. Construct gas fired boilers in accordance with American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section IV.
    - b. Install gas-fired boilers in accordance with ASME-CSD-1, Controls and Safety Devices for automatically fired boilers.
  - 3. UL Labels: Provide gas fired boiler ancillary electrical components which have been listed and labeled by Underwriters Laboratories (UL).
  - 4. Wisconsin Administrative Code: Install gas-fired boilers in accordance with Chapter 46, Installation of Steam Heating Boilers Hot Water Heating Boilers and Hot Water Supply Boilers.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed and operating), furnished specialties and accessories and installation and start up instructions.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and methods of assembly of components.

- C. Wiring Diagrams: Submit ladder type wiring diagrams for power and control wiring required for final installation of boilers and controls. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

## **1.5 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

## **1.6 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Handle boiler and equipment carefully to prevent damage, breaking and scoring. Do not install damaged equipment or components; replace with new.
- B. Store boiler and equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

## **PART 2 - GENERAL**

### **2.1 RELATED WORK**

- A. High Efficiency Modular Gas fired Boilers
  - 1. Aerco

### **2.2 HIGH EFFICIENCY GAS FIRED BOILERS**

- A. General: Provide as indicated, factory assembled and tested packaged gas fired boilers, of capacity, performance and sizing as scheduled. Provide design certified by AGA, heating capacities based on standard test procedures prescribed by DOE, and constructed in accordance with requirements of the ASME Boiler and Pressure Vessel Code and ASME CSD-1.
- B. Condensing fire-tube, counter-flow design incorporating a helical fire tube assembly. Assembly shall be self-supporting, baffle free and design to resist thermal shock. Heat exchanger shall be ASME stamped with 150 psi rating.
- C. Full modulating burner, with 20:1 firing rate turn-down, direct vented, sealed combustion unit.
- D. UL Listed factory-packaged burner controls, including interrupted spark ignition and rectification type flame sensor. Controls shall include a LCD display for monitoring sensors and interlocks.
- E. Factory packaged gas train including modulating control valve and automatic safety shut-off valve. Unit shall have maximum operating pressure of 2.0 psi and minimum operating pressure of 5.3" wc.
- F. Safety controls shall include electric low-water cutoff probe, dual over temperature protection including manual reset and remote fault alarm contacts. Boiler controls shall meet ASME Section IV and CSD-1 requirements.
- G. Single point electrical connection, 120 volt, single phase.

- H. The boiler shall be controlled by a factory packaged controller which shall modulate the boiler firing rate in response to a remote Heating Hot Water Temperature input and setpoint from the Building DDC system. The boiler controller shall register alarm faults and firing rate to Building DDC. Where multiple boilers operate in parallel, one master controller shall control the firing rate of all boilers in the system with capabilities of staging boilers on/off based on load demand.
- I. Accessories:
  - 1. ASME Pressure Relief Valve: 75 psi
  - 2. Combustion Air Piping: Schedule 40 PVC.
  - 3. Exhaust Flue Piping: Heat-Fab Saf-T Vent, double wall AL 29-4C stainless steel. UL-listed for direct vent appliances.
  - 4. Condensate neutralization tank sized for capacity of all boilers it serves.
  - 5. Hot water control valve for each boiler.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine areas and conditions under which boiler is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION OF BOILER**

- A. General: Comply with boiler manufacturer's instructions for installation, except as otherwise indicated.
- B. Comply with installation requirements of local and state boiler codes, and applicable provisions of NFPA and ASME boiler code standards.
- C. Install boilers on 4" high concrete pad where indicated, maintain manufacturer's recommended clearances around and over top of boilers.
- D. Install boiler trim not installed at factory.
- E. Connect water and fuel piping and breeching as indicated.
- F. Furnish to Electrical Installer, manufacturer's wiring diagram and electrical requirements for installation of field wiring required for power to boilers; not work of this section.
- G. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start up instructions.
- H. Start up boiler, in accordance with manufacturer's start up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- I. Hydrostatically test assembled boiler and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.

#### **3.3 TRAINING OF OWNER'S PERSONNEL**

- A. Provide services for manufacturer's technical representative to instruct Owner's personnel in operation and maintenance of boiler.

- B. Schedule training with Owner, provide at least 7 day notice to Contractor and Design Professional of training date.

**END OF SECTION 23 52 16**

## SECTION 23 62 00 - PACKAGED COMPRESSOR AND CONDENSER UNITS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of condensing unit work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of condensing units in this section include the following:
  - 1. Air cooled condensing units.
- C. Refer to other Division 23 sections for piping, refrigeration specialties, etc., required external to condensing units for installation; not work of this section.
- D. Refer to Division 26 sections for field installed power wiring required for condensing units; not work of this section.

#### 1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. ARI Compliance: Provide capacity ratings for condensing units in accordance with Air Conditioning and Refrigeration Institute (ARI) Standard 360 "Standard for Commercial and Industrial Unitary Air Conditioning Equipment" and ARI 210 "Standard for Unitary Air Conditioning Equipment".
  - 2. ASHRAE Compliance: Construct refrigerating system of condensing units in accordance with American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard ANSI/ASHRAE 15, "Safety Code for Mechanical Refrigeration".
  - 3. UL Compliance: Provide condensing units which are listed by Underwriters Laboratories (UL) and have UL label affixed.
- B. Warranty:
  - 1. Provide one year warranty on all parts except compressor.
  - 2. Provide five year warranty on compressor.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points and installation and start up instructions.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

## **1.5 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

## **1.6 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Handle condensing units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged condensing units or components; replace with new.
- B. Store condensing units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Air cooled Condensing Units
  1. Lennox Industries, Inc. (units up to 15 tons)
  2. Trane Company
  3. Daikin Applied
  4. Johnson Controls/York

### **2.2 GENERAL**

- A. Provide factory assembled and tested air cooled condensing units as indicated, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. Provide capacity and electrical characteristics as scheduled.

### **2.3 UNITS UP TO 5 TONS**

- A. Casing: Provide 18 gauge galvanized steel casing finished with baked enamel. Provide removable panel for access to controls, and weep holes for drainage. Provide base with mounting holes. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Provide welded hermetic with built in overloads and vibration isolation. Provide for compressor motor, thermal and current sensitive overload device, internal high pressure protection, high and low pressure cutout switches, start capacitor and relay, 2 pole contactor, crankcase heater, and temperature actuated switch and timer to prevent compressor rapid cycle.
- C. Condenser: Construct coil of copper tubes and aluminum fins, provided with liquid accumulator and liquid subcooler. Provide aluminum propeller fan, direct driven, with permanently lubricated fan motor with thermal overload protection.



- D. Provide the following accessories:
1. Low voltage thermostat to control condensing unit and evaporator fan. Provide 7 day programmable thermostat with individual temperature setpoints for occupied heat and cool and unoccupied heat and cool. Thermostat shall have automatic heat/cool changeover, 3 hour override of unoccupied program and battery backup. Thermostat shall be Honeywell T 7200.
    - a. In the occupied mode, the fan shall run continuously. In the unoccupied mode the fan shall cycle.
    - b. In the occupied mode the outdoor air damper shall open. In the unoccupied mode, it shall close.
  2. Precharged and insulated suction and liquid tubing of length indicated. (Contractor option.)
  3. Head pressure control to modulate condenser fan motor speed for low ambient conditions.
  4. Low voltage control transformer.
  5. Low and high pressure switches
  6. Crankcase heater
  7. Filter dryer
  8. Anti-short cycle control

#### 2.4 UNITS FROM 7-1/2 TO 15 TONS

- A. Casing:
1. Casing shall be constructed of 18 gauge galvanized steel.
  2. Exterior surfaces shall be cleaned, phosphatized and finished with a weather resistant baked enamel finish.
  3. Unit surfaces shall be tested 500 hours in salt spray test.
  4. Units shall have removable end panels which allow access to all major components and controls.
- B. Compressors:
1. 7-1/2 Tons:
    - a. Single direct drive hermetic reciprocating compressor.
    - b. Unit shall include oil pump, crank case heater, temperature and current overloads, internal spring isolation, and external high and low pressure cutout devices.
  2. 10 - 20 Tons:
    - a. Dual direct drive hermetic reciprocating compressors.
    - b. Unit shall include oil pump, crank case heater, temperature and current overloads, internal spring isolation, and external high and low pressure cutout devices.
- C. Refrigerant Circuits:
1. 7-1/2 Tons: Single Refrigerant Circuit.
  2. 10 - 20 Tons: Dual Refrigerant Circuits.
  3. Each refrigerant circuit shall have the following:
    - a. Integral subcooling circuit.
    - b. Filter dryer.
    - c. Liquid and suction line service valves and gauge port.

- D. Condenser:
1. Condenser coils shall be constructed of aluminum fins mechanically bonded to seamless copper tubing. Condensers shall be factory leak tested at 450 psig air pressure underwater.
  2. Provide with direct drive, statically and dynamically balanced vertical discharge fins.
  3. Motors shall have permanently lubricated ball or sleeve bearings and thermal overload protection.

E. Provide the following:

1. Factory wired controls.
2. Anti-short cycle times.
3. Low ambient operation to 0°F.
4. Hot gas bypass lite.
5. Time delay relay.
6. Condenser coil guard.
7. Non-fused disconnect.

## 2.5 UNITS FROM 20 TO 60-TONS

A. Casing:

1. Casings shall be constructed of a 14-gauge welded galvanized steel frame. Panels and access doors shall be 14 and 16-gauge galvanized steel.
2. The unit surface shall be phosphatized and finished with air-dry paint which shall exceed 500 consecutive hour salt spray resistance in accordance with ASTM B117.
3. Provide units with factory-installed decorative louvered grills to protect the condenser coils.

B. Compressor:

1. Compressors shall be scroll or reciprocating type.
2. Unit shall include centrifugal oil pump, inlet dirt separator, journal bearings, oil sight glass, oil charging valve and solid internal suspension.

C. Condenser:

1. Condenser coils shall be constructed of aluminum fins mechanically bonded to seamless copper tubing with an integral subcooler. Condensers shall be factory leak tested at 450 psig air pressure underwater.
2. Provide with direct drive, statically and dynamically balanced vertical discharge fans.
3. Three-phase motors shall have permanently lubricated ball bearings and thermal overload protection.

D. Refrigerant Circuits and Capacity Modulation:

1. 20 through 30-ton sizes shall be single circuit and have two steps of capacity.
2. 40 through 60-ton sizes shall be two circuits with four capacity steps. Each circuit shall be fed by two compressors piped in parallel.

E. Provide with the following accessories:

1. Low ambient controls to allow operation down to 0°F.
2. Hot gas by-pass.

3. Non-fused disconnect.
4. Multi-step, demand oriented microprocessor-based discharge air controller, equal to Honeywell W7100A, including discharge air sensor (VAV applications only).
5. Coil frost protection controls (VAV applications only).

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine areas and conditions under which condensing units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

#### **3.2 INSTALLATION OF CONDENSING UNITS**

- A. General: Install condensing units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Install ground mounted units on 4" thick reinforced concrete pad, 4" larger on each side than condensing unit. Anchor unit to pad using inserts or anchor bolts.
- C. Electrical: Furnish electrical field wiring diagrams to Electrical Contractor for power wiring to condensing units.
- D. Air Cooled Condensing Units: Connect refrigerant piping to unit; run piping so as to not interfere with access to unit.
  1. Install furnished field mounted accessories.
  2. Refrigerant piping shall be insulated in accordance with the requirements of Section 23 07 00 – HVAC Insulation.
  3. All control wiring shall be the responsibility of the HVAC Contractor.
  4. Install flexible piping connection for units mounted on spring isolators.
- E. Start up condensing units, in accordance with manufacturer's start up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

#### **3.3 TRAINING OF OWNER'S PERSONNEL**

- A. Instruct Owner's personnel in operation and maintenance of condensing units.

**END OF SECTION 23 62 00**

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## SECTION 23 64 16 - CENTRIFUGAL WATER CHILLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 SUMMARY

- A. This Section includes packaged, water-cooled, electric-motor-driven, centrifugal water chillers.

#### 1.3 DEFINITIONS

- A. EER: Energy-efficiency ratio.
- B. IPLV: Integrated part-load value.

#### 1.4 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Complete set of manufacturer's certified prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
  - 1. Assembled unit dimensions.
  - 2. Operating weight and load distribution.
  - 3. Required clearances for maintenance and operation.
  - 4. Size and location of piping and wiring connections.
  - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans drawn to scale and coordinated with the following:
  - 1. Structural supports.
  - 2. Piping roughing-in requirements.
  - 3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
  - 4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
- D. Certificates: For certification required in "Quality Assurance" Article.
- E. Source quality-control test reports.
- F. Startup service reports.
- G. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
- H. Warranties: Special warranties specified in this Section.

## **1.5 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

## **1.6 QUALITY ASSURANCE**

- A. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
- B. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Comply with NFPA 70.
- D. Comply with UL 1995.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Ship water chillers from the factory fully charged with refrigerant or nitrogen.

## **1.8 COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Daikin Applied.
  - 2. YORK International Corporation.
  - 3. Trane Company

### **2.2 PACKAGED WATER CHILLERS**

- A. Description: Factory-assembled and -tested water chiller complete with compressor, evaporator, condenser, controls, interconnecting unit piping and wiring, indicated accessories, and mounting frame.

### **2.3 COMPRESSORS**

- A. Description: Variable displacement.
  - 1. Casing: Cast iron, precision ground.

2. Impeller: High strength, cast-aluminum alloy on carbon- or forged-steel shaft; dynamically balanced.
- B. Capacity Control: Variable-inlet guide-vane assembly for stable operation that is free of surge, cavitation, or vibration throughout throttling range from 100 to 10 percent of full load.
  - C. Oil Lubrication System: Positive-displacement submersible pump with heater, oil filter, and sight glass.
  - D. Refrigerant and Oil: HFC-134a.

## 2.4 HEAT EXCHANGERS

- A. Evaporator:
  1. Description: Shell-and-tube design, ASME labeled.
  2. Shell Material: Carbon steel.
  3. Tube Construction: Individually replaceable, expanded into tube sheets.
    - a. Material: [Copper] [Copper-nickel alloy] [Titanium] [Copper, copper-nickel alloy, or titanium].
    - b. Minimum Size: 3/4-inch OD; 0.028-inch wall thickness.
    - c. Internal Finish: [Enhanced] [Smooth].
  4. Water Box: Standard, with design working pressure of 150 psig, and having flanged water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle.
- B. Condenser:
  1. Description: Shell-and-tube design, ASME labeled.
  2. Shell Material: Carbon steel.
  3. Tube Construction: Externally enhanced and individually replaceable, expanded into tube sheets.
    - a. Material: [Copper] [Copper-nickel alloy] [Titanium] [Copper or copper-nickel alloy].
    - b. Minimum Size: 3/4-inch OD; 0.028-inch wall thickness.
    - c. Internal Finish: [Enhanced] [Smooth].
  4. Water Box: Standard, with design working pressure of 150 psig, and having flanged water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle.

## 2.5 INSULATION

- A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type II, for sheet materials.
  1. Thickness: 1-1/2 inches.
  2. Adhesive: As recommended by insulation manufacturer.
  3. Factory apply insulation over entire surfaces of water chiller components.
    - a. Apply adhesive to 100 percent of insulation contact surface.
    - b. Seal seams and joints.
    - c. After adhesive has fully cured, apply two coats of protective coating to insulation.

## 2.6 ACCESSORIES

- A. Pressure Relief Valve: Single- or multiple-reseating-type, spring-loaded relief valve.

## 2.7 CONTROLS

- A. Control Panel: Stand-alone, microprocessor based.
- B. Enclosure: Unit-mounted, NEMA 250 enclosure, hinged or lockable; factory wired with a single-point power connection and a separate control circuit.
- C. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad.
- D. Control Functions:
  - 1. Manual or automatic startup and shutdown time schedule.
  - 2. Entering and leaving chilled-water temperatures, control set points, and motor load limit.
  - 3. Current limit and demand limit.
  - 4. Condenser-water temperature.
  - 5. External water chiller emergency stop.
- E. Manually Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
  - 1. Low evaporator [pressure] [temperature]; high condenser pressure.
  - 2. Low chilled-water temperature.
  - 3. Low oil differential pressure.
  - 4. High or low oil pressure.
  - 5. High oil temperature.
  - 6. High compressor-discharge temperature.
  - 7. Loss of chilled- or condenser-water flow.
  - 8. Electrical overload.
  - 9. Sensor- or detection-circuit fault.
  - 10. Processor communication loss.
  - 11. Starter fault.
  - 12. Extended compressor surge.
  - 13. Excessive air-leakage detection.
- F. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control chilled-water set point and chiller-control displays and alarms.

## 2.8 MOTORS

- A. Comply with requirements in Division 23 Section 23 0513 - Common Motor Requirements for HVAC Equipment.
  - 1. Open-drive motors shall have flanged or flexible coupling suitable for direct connection to compressor.



## 2.9 VARIABLE-FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
1. Enclosure: Unit mounted, NEMA 250, Type 1, with hinged access door with lock and key.
- B. Output Rating: 3-phase; 6 to [60 Hz, with voltage proportional to frequency throughout voltage range] [66 Hz, with torque constant as speed changes] [120 Hz, with horsepower constant throughout speed range].
- C. Provide Short Circuit Current Rating (SCCR) and AIC rating (if applicable) of 65,000. The Short Circuit Rating is the rating of the panel to withstand a short circuit of the specified amps. This rating is separate from the AIC rating of Circuit Breakers.
- D. Unit Operating Requirements:
1. Input AC Voltage Tolerance: [460-V ac, plus 10 percent or 506 V maximum] <Insert other voltage and tolerance>.
  2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
  3. Capable of driving full load, under the following conditions, without derating:
    - a. Ambient Temperature: 0 to 40 deg C.
    - b. Humidity: Less than 90 percent (noncondensing).
    - c. Altitude: 3300 feet.
  4. Minimum Efficiency: 96 percent at 60 Hz, full load.
  5. Minimum Displacement Primary-Side Power Factor: 95 percent without optional harmonic filter, and 98 percent with optional filter.
  6. Overload Capability: 1.05 times the full-load current for 7 seconds.
  7. Starting Torque: 100 percent of rated torque or as indicated.
  8. Speed Regulation: Plus or minus 1 percent.
  9. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
- E. Internal Adjustability Capabilities:
1. Minimum Speed: 50 percent of maximum rpm.
  2. Maximum Speed: 100 percent of maximum rpm.
  3. Acceleration: 2 to a minimum of 12 seconds.
  4. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- F. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
  2. Snubber networks to protect against malfunction due to system voltage transients.
  3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
  4. Motor Overload Relay: Adjustable and capable of NEMA 250, Class [10] [20] [30] performance.
  5. Instantaneous line-to-line and line-to-ground overcurrent trips.
  6. Loss-of-phase protection.
  7. Reverse-phase protection.
  8. Short-circuit protection.
  9. Motor overtemperature fault.

- G. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
  - 1. Maximum Restarts per Hour: 15.
- H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- I. Input Line Conditioning: <Insert requirements.>
- J. Status Lights: Door-mounted, liquid-crystal-display or light-emitting-diode indicators shall indicate the following conditions:
  - 1. Power on.
  - 2. Run.
  - 3. Overvoltage.
  - 4. Line fault.
  - 5. Overcurrent.
  - 6. External fault.
- K. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- L. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
  - 1. Output frequency (Hz).
  - 2. Motor speed (rpm).
  - 3. Motor status (running, stop, fault).
  - 4. Motor current (amperes).
  - 5. Fault or alarming status (code).
  - 6. DC-link voltage (V dc).
  - 7. Motor output voltage (V).
- M. Control Signal Interface:
  - 1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
  - 2. Remote Signal Inputs: Keypad display for local hand operation. Capability to accept the following speed-setting input signals from building management system or other control systems through an RS485 interface:
    - a. 0 to 10-V dc.
    - b. 0-20 or 4-20 mA.
    - c. Potentiometer using up/down digital inputs.
    - d. Fixed frequencies using digital inputs.
  - 3. Output Signal Interface:
    - a. A minimum of 1 analog output signal (0/4-20 mA) that can be programmed to any of the following:
      - 1) Output frequency (Hz).
      - 2) Output current (load).
      - 3) DC-link voltage (V dc).
      - 4) Motor speed (rpm).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
  - a. Motor running.
  - b. Fault and warning indication (overtemperature or overcurrent).
  - c. High or low speed limits reached.
  - d. Power-interruption protection.
- N. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.
- O. Harmonic Distortion Filter: Factory mounted and wired and complying with IEEE 519.
- P. Accessories: Devices shall be factory installed in controller enclosure, unless otherwise indicated.
  1. Control Relays: Auxiliary and adjustable time-delay relays.

## **2.10 SOURCE QUALITY CONTROL**

- A. Factory test and rate water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle." Stamp with ARI label.
- B. Factory test heat exchangers hydrostatically at 1.50 times the design pressure.
- C. Factory test and inspect evaporator and water cooled-condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- D. Factory test and inspect water boxes at 150 percent of working pressure.
- E. Rate sound power level according to ARI 575 procedure.
- F. Allow Owner access to places where water chillers are being source quality-control tested. Notify Design Professional 14 days in advance of testing.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Before water chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
  1. Final water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 WATER CHILLER INSTALLATION**

- A. Install water chillers on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Concrete Bases: Anchor chiller mounting frame to concrete base.
  1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
  5. Cast-in-place concrete materials and placement requirements are specified in Division 03.
- C. Vibration Isolation: Rubber pads with a minimum deflection of [0.25 inch] <Insert deflection>. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
  - D. Vibration Isolation: Restrained neoprene isolators with a minimum deflection of <Insert deflection>. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
  - E. Vibration Isolation: Mount water chiller on vibration isolation equipment base as specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
  - F. Maintain manufacturer's recommended clearances for service and maintenance.
  - G. Charge water chiller with refrigerant if not factory charged.
  - H. Install separate devices furnished by manufacturer.

### 3.3 CONNECTIONS

- A. Chilled- and condenser-water piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water chillers to allow service and maintenance.
- C. Evaporator Connections: Connect inlet to evaporator with controller-bulb well, shutoff valve, thermometer, strainer, pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, flow switch, balancing valve, thermometer, pressure gage, and union or flange.
- D. Condenser Connections: Connect inlet to condenser with shutoff valve, thermometer, plugged tee, and pressure gage. Connect outlet to condenser with shutoff valve, thermometer, drain line and shutoff valve, strainer, and plugged tee.
- E. Install shutoff valves at chilled-water and condenser-water inlet and outlet connections.
- F. Refrigerant Pressure Relief Valve Connections: Extend vent piping to the outside without valves or restrictions.
- G. Ground water chillers according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### **3.4 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
  - 2. Verify that pumps are installed and functional.
  - 3. Verify that thermometers and gages are installed.
  - 4. Operate water chiller for run-in period according to manufacturer's written instructions.
  - 5. Check bearing lubrication and oil levels.
  - 6. Verify that refrigerant pressure relief is vented outside.
  - 7. Verify proper motor rotation.
  - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
  - 9. Verify and record performance of chilled- and condenser-water flow and low-temperature interlocks.
  - 10. Verify and record performance of water chiller protection devices.
  - 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Prepare a written startup report that records results of tests and inspections.
- E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

### **3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Refer to Division 01 Section "Demonstration and Training."

**END OF SECTION 23 64 16**

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## SECTION 23 65 00 - COOLING TOWERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of factory fabricated cooling tower work is indicated on drawings and by provisions of this section, including schedules and equipment lists associated with either drawings or this section.
- B. Types of factory fabricated cooling towers required for project include the following:
  - 1. Induced-Draft Crossflow
- C. Refer to Division 26 sections for power wiring to factory fabricated cooling towers; not work of this section.
- D. Refer to Division 23, Section 23 0548 - Vibration Controls for HVAC Piping, Ductwork and Equipment for vibration isolation work required in conjunction with factory fabricated cooling towers; not work of this section.

#### 1.3 QUALITY ASSURANCE

- A. Provide manufacturer's certification of tower cooling capacity, based on factory performance tests, and provide performance curve plotting Leaving Water Temperature (LWT) against Wet Bulb Temperature (WBT).
- B. Cooling tower thermal performance shall be certified by Cooling Tower Institute (CTI) in accordance with CTI Certification Standard STD-201.
- C. UL and NEMA Compliance: Provide electric motors and electrical components required as part of factory fabricated cooling towers, which have been listed and labeled by Underwriters' Laboratories and comply with NEMA Standards.
- D. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of factory fabricated cooling towers.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications, including rated capacities, pressure drop, fan performance data, weights (shipping, installed, and operating), installation and start up instructions, and rating curves with selected points clearly indicated.
- B. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of all components.

- C. Wiring Diagrams: Submit ladder type wiring diagrams for motors and control components, clearly indicating all required field electrical connections.
- D. Maintenance Data: Submit maintenance data and parts list for each cooling tower. Include "trouble shooting" maintenance guide. Include this data in maintenance manual.

## **1.5 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Induced Draft Crossflow
  - 1. Baltimore Air Coil
  - 2. Evapco
  - 3. Imeco
  - 4. SPX/Marley
  - 5. Delta Towers
  - 6. Evapco

### **2.2 FACTORY FABRICATED COOLING TOWERS**

- A. General
  - 1. Provide factory-assembled induced draft, vertical discharge, crossflow type cooling towers where shown.
  - 2. All Steel components shall be made from G235 hot dip galvanized steel, with all edges given a protective coat of zinc rich compound. In addition, a final coating of Zinc Chromated Aluminum shall be applied to the unit after assembly to provide additional corrosion protection.
- B. Capacity: The Induced Draft Crossflow tower shall have a capacity as indicated on the schedule.
- C. Fan Assembly:
  - 1. Propeller type fan with cast aluminum blades, cast aluminum or cast iron hub.
  - 2. Fan bearings shall be heavy duty, self-aligning, grease packed ball bearings and designed for minimum L-10 life of 40,000 h.
  - 3. Fan drive shall be either helical gear reducer connection to motor or belt drive utilizing one-piece multi-groove, neoprene/polyester belt designed specifically for cooling tower service.
  - 4. Fan motor shall be single speed, totally enclosed fan cooled (TEFC) or totally enclosed air over (TEAO), 1800 rpm, designed for cooling tower service.
  - 5. Fan motor shall have a 65,000 AIC Short Circuit Current Rating (SCCR).



D. Distribution Basins:

1. One piece welded or bolted design, self-cleaning and complete with depressed center section, cleanout and drain fitting, side outlet or bottom outlet as shown with suction screen and anti-cavitation device.
2. Where multiple cells are used, furnish cells with water level equalizing lines to form common sump.
3. Basin shall be constructed of heavy gauge 304 or 301 L stainless steel.

E. Fill and Drift Eliminators and Louvers:

1. Fill and drift eliminator shall be noncorrosive, nonferrous polyvinyl chloride (PVC). Fill shall be noncombustible with flame spread rating of no more than 25 per ASTM E84. Vertical sheet fill material shall be adequately reinforced to prevent sagging.
2. Construct drift eliminators of polyvinyl chloride (PVC) limiting drift loss to 0.005% of design flowrate.
3. Louvers to be fiberglass reinforced polyester (FRP) or PVC with galvanized wire air inlet screens.

F. Access and Safety:

1. Furnish access doors at each end of tower assemblies for access to eliminator and plenum section.
2. Furnish heavy gauge, galvanized wire, grille type fan guard over each fan cylinder.
3. Furnish galvanized steel or aluminum ladder and handrail constructed in accordance with OSHA Standards.
4. Ladder shall have sufficient length for service.
5. Provide access platform on one side of tower to allow for access into tower. Provide access ladder from roof to access platform.
6. Internal access to be achieved by a G-235 galvanized steel walkway complying with OSHA standards and regulations provides access to the plenum to facilitate servicing the unit. Walkway submerged mounting supports to match the cold water basin material of construction.

G. Basin Water Level Control:

1. Provide factory installed water level control system including NEMA 4X control panel, water level probes and probe stilling chamber. Control system shall monitor water level in cold water basin to determine level events used for cold water make-up, high and low alarms or pump shut down. Control panel shall use electromechanical relays providing power for slow acting make-up solenoid valve and electrical contacts for alarm and pump shutdown control circuits. Probes shall be contained in vertical stilling chamber to stabilize water in cold-water basin. Probes shall have replaceable stainless steel tips and level height shall be field adjustable. The number and position of water level sensing devices shall be provided to sense the following:
  - a. high water level
  - b. low water level
  - c. high water alarm level
  - d. low water alarm level

- H. Basin Sweeper Piping: Polyvinyl chloride (PVC) sump sweeper piping to be included in the cold water basin. Supply and return connections are provided for connecting to a pumped centrifugal separator filtration system. Pumped filtration system to be capable of supplying 20 psig pressure that is required at the cooling tower water inlet.

- I. Accessory Equipment:
  - 1. Furnish electric basin heater package for Cooling Towers CT-1 and CT-2, including immersion heater to maintain water temperature in pan at 40°F at -15°F outside air temperature.
  - 2. Furnish unit with vibration cutout switch mounted to fan support framework. Switch shall shut off fan motor when subject to excessive vibration.
  - 3. Fan motor space heater.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General: Comply with cooling tower manufacturer's instructions for installation, except as otherwise indicated.
- B. Examine conditions under which cooling towers are to be installed. Correct all unsatisfactory conditions before proceeding with the work.
- C. Level units to a tolerance of 1/8" in 10'0", in both directions.
- D. Install gaskets or sealants between cooling tower cells.
- E. Connect supply and return lines to cooling towers with flanged connections.
- F. Install flexible connections on supply, return, and water make up lines.
- G. Connect water make up line to automatic fill valve with 3 valve bypass.
- H. Connect bleed line as recommended by manufacturer.
- I. Connect drain and overflow as indicated, run full size to drain.
- J. Furnish electrical wiring diagrams to Electrical Installer for installation of power wiring; not work of this section.

#### **3.2 START UP**

- A. General: Clean tower thoroughly. Comply with manufacturer's instructions for filling and start up of operation, but not less than the following:
  - 1. Verify lubrication of rotating parts; lubricate as needed.
  - 2. Verify fan rotation direction.
  - 3. Verify that motor amperage is in accordance with manufacturer's data.
  - 4. Adjust water level control for proper operating level.
  - 5. Adjust bleed valve for indicated percentage of circulated water volume.
  - 6. Passivate cooling tower in accordance with manufacturer's instructions. See Division 23 Section 23 2113 – Hydronic Piping for additional requirements.

**END OF SECTION 23 65 00**

## SECTION 23 73 13 - MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install air handling units as required by the drawings and this section.

#### 1.3 QUALITY ASSURANCE

- A. ARI Compliance: Units shall have certified ratings complying with ARI Standard 430.

#### 1.4 SUBMITTALS

- A. Submittal data shall consist of drawings and/or catalog cuts giving dimensions, arrangement, construction materials, fan performance curves, coil capacity, horsepower, electrical characteristics and installation instructions.

#### 1.5 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Air Handling Units
  - 1. Daikin Applied
  - 2. Trane Company – M Series
  - 3. JCI/York International - Solution

#### 2.2 GENERAL

- A. Units shall be factory built and assembled with arrangements as indicated on the drawings.
- B. Units shall have capacities, ratings and performance as scheduled.

## 2.3 CASINGS

- A. Unit casings shall be fabricated of heavy gauge steel reinforced with steel angle framework as required for smooth operation for pressure rating. Casings shall be sectionalized with separate fan and coil sections. Units casing shall be of double-wall construction.
- B. Casing insulation shall be spray-injected foam. Casing panel shall be a minimum of R-13.
- C. Fan sections shall have perforated, galvanized inner liners. Perforated panel shall be a minimum of R-11.
- D. Casings shall have hinged panels to provide access to all internal components. All access doors shall have a minimum clear opening dimension of 10".
- E. IAQ drain pans shall be provided under the complete coil section and double pitched to the drain connection to promote positive drainage. Drain pans shall be double-wall insulated. Drain pans shall be constructed of stainless steel. Drain pans shall comply with ASHRAE 62.1.

## 2.4 FANS

- A. Fans shall be plenum type..
- B. Bearings shall be grease lubricated ball bearings selected for 200,000 hours average life.
- C. Fans shall be statically and dynamically balanced and factory run tested, in the unit.
- D. Fan and motor assembly shall be internally isolated from unit casing with factory mounted spring isolators. Fan scroll shall be attached to the unit by a flexible canvas duct.
- E. Fan and sheave combinations shall be selected to operate at design conditions without exceeding variable frequency drive speeds of 100 Hz. Combinations requiring operation above 100 Hz are not acceptable.
- F. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.
- G. Backdraft Dampers
  - 1. Counter-balanced backdraft damper Ruskin model CBD6 or equal.
    - a. Frame: Heavy duty 0.125" thick aluminum
    - b. Blades: 0.070 thick aluminum with extruded vinyl edge seals
    - c. Bearings: Zytel
    - d. Linkage: 0.125" thick aluminum tie bars
    - e. Counterbalance: Zinc plated bar mounted on blades with adjustability for job site final setting
    - f. Temperature: -40 deg F to 200 deg F
    - g. Back Pressure:
      - 1) 48" section width – up to 4" wc
      - 2) 36" section width – up to 8" wc
      - 3) 24" section width – up to 12" wc
      - 4) 12" section width – up to 16" wc
    - h. Operation: blades start to open at 0.01" wc and are fully open at 0.05" wc

## **2.5 COILS**

- A. Coils shall be furnished for heating and/or cooling media as scheduled on the drawings.
- B. Coils shall be aluminum fin, copper tube type. Fins shall have drawn, belled collars bonded to the tubes by means of mechanical expansion of the tubes. Coil casings shall be galvanized steel.
- C. Steam coils shall be non-freeze, double tube, steam distribution type to assure even steam distribution over the full length of each tube.
- D. Hot water heating coils shall be of the metering type with metering orifices in the supply header to insure equal distribution of water to each tube.
- E. Chilled water cooling coils shall be completely drainable, and shall be pitched in the unit casing for proper drainage.

## **2.6 MOTORS AND DRIVES**

- A. Motors shall be NEMA Premium Efficiency, normal torque, 40 deg. C rise, splash proof, of horsepower rating and electrical characteristics as scheduled on the drawings. Motors shall be suitable for use with variable frequency drives.
- B. Drives shall be rated at 1.25 times the motor horsepower rating. Drives up to and including 40 horsepower shall be adjustable speed drives (don't use on over 50 HP) for adjustment within plus or minus 10% of specified RPM. Units shall be furnished with approved drive guards.
- C. Motor shall be mounted on an adjustable mount, suitable for adjusting belt tension and drive alignment.
- D. ECM motors are an acceptable alternate to standard motors and drives.

## **2.7 FILTER MODULES**

- A. Filter modules shall be furnished with face area and performance as scheduled on drawings. Modules shall consist of side-access filter racks, access doors, and filter blank-offs. Filter module requirements shall be coordinated with filter media specified in separate section.
- B. 4" Cartridge Filters: Provide Gasketed side-access filter racks suitable to support 4" deep high efficiency cartridge type filters with 7/8" headers. Filters to be MERV-11.
- C. 12" HEPA Cartridge Filters: Provide Gasketed side-access filter racks suitable to support 12" deep HEPA cartridge type filters.
- D. Gas-Phase Filters: Provide Gasketed side-access filter racks suitable to support activated carbon absorbers with 7/8" headers. Module shall include filter rack for 2" pleated media throw-away pre-filters and post-filters.

## **2.8 FILTER MIXING BOXES**

- A. Combination filter mixing boxes shall have parallel damper blades for internal merging of airstreams. Leaving side shall have bolt holes compatible with unit and other accessories. Mixing box shall be designed to hold 2" pleated throw-away filters, MERV 8A minimum or as scheduled. Provide with full size access door. Dampers shall be low leak type construction with metal compressible jamb seals and extruded vinyl blade edge seals, mechanically locked into the blade edge, on both the outdoor air and return air. Leakage shall not exceed 5 cfm/sf at one-inch wg. All leakage testing and pressure ratings will be based on AMCA Publication 500.

## **2.9 INLET, RELIEF AND MIXED AIR DAMPER**

- A. Provide low leak type dampers with metal compressible jamb seals and extruded vinyl blade edge seals. Leakage shall not exceed five cfm per square foot at one-inch wg. All leakage testing and pressure ratings will be based on AMCA Publication 500.

## **2.10 AIR BLENDER**

- A. Manufacturer: Blender Products Inc or approved equal.
  - 1. Units shall be not less than 0.08" aluminum of all welded construction.
  - 2. Units shall be completely fixed devices capable of providing mixed air temperatures within 6°F of theoretical values.
  - 3. Refer to drawings for units that require air blenders.

## **2.11 VARIABLE FREQUENCY DRIVES**

- A. Variable frequency drives (VFDs) to be provided by air handling unit manufacturer. VFDs to be mounted on air handling unit. Where multiple supply fans serve one air handling unit, one VFD shall operate all fans in the fan array. Where multiple return fans serve one air handling unit, one VFD shall operate all fans in the fan array.
- B. Base VFD type on results of IEEE-519 study with minimum configuration as follows (NOTE: total horsepower connected to a VFD shall be used when calculating harmonic mitigating technology, e.g. (4) 15HP fans = 60HP.):
  - 1. Less than 40 HP – 6 pulse drive with 5% reactor.
  - 2. 40HP up to 75HP – 6 pulse drive with 5% reactor and passive harmonic filter or 12 pulse drive.
  - 3. Larger than 75HP – 18 pulse drive or active front end filter.
  - 4. Engineered solution specific to the project requirements that employs harmonic mitigation equipment and is submitted for Engineer approval prior to bidding.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install units and make piping and duct connections as indicated on the drawings.
- B. For units with water heating and/or cooling coils, install balancing cock, pressure and temperature test stations and shut off valve in return lines. In supply line, install shut off valve, and automatic control valve. Install flexible piping connectors at steam coil connections.
- C. Extend condensate drain line to nearest floor drain and elbow into drain. Condensate waste shall be trapped at drain pan, with screwed cleanout plug in low point of trap. Multiple condensate discharges shall be trapped separately, as close to the unit as possible. The effective trap seal shall be two (2) times the suction pressure of the fan in inches for draw through units, but not less than three (3) inches.
- D. Provide equipment base rail or housekeeping pad as required to maintain required height for installation of all piping and ductwork connections to unit including condensate traps.

- E. Provide one complete extra set of filters for each air handling system. If system is designed to include pre-filters and after-filters, provide only pre-filters. Install new filters at completion of air handling system and prior to testing, adjusting and balancing work. Obtain receipt from Owner that new filters have been installed.

**END OF SECTION 23 73 13**

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## **SECTION 23 74 13 - PACKAGED, OUTDOOR, CENTRAL STATION AIR HANDLING UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED WORK**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### **1.2 DESCRIPTION OF WORK**

- A. Provide material, equipment, labor and supervision necessary to install air handling units as required by the drawings and this section.

#### **1.3 QUALITY ASSURANCE**

- A. ARI Compliance: Units shall have certified ratings complying with ARI Standard 430.

#### **1.4 SUBMITTALS**

- A. Submittal data shall consist of drawings and/or catalog cuts giving dimensions, arrangement, construction materials, fan performance curves, coil capacity, horsepower, electrical characteristics and installation instructions.

#### **1.5 COMMISSIONING**

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

### **PART 2 - PRODUCTS**

#### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Acceptable Manufacturers and Models
  - 1. Daikin Applied
  - 2. Trane Company
  - 3. JCI/York International
- B. Acceptable Manufacturers and Models
  - 1. Trane Company - T Series Modular Penthouse Climate Changes

#### **2.2 AIR HANDLING UNITS**

- A. Units shall be factory built and assembled with arrangements as indicated on the drawings.
- B. Units shall have capacities, ratings and performance as scheduled.

### **2.3 CASINGS (INTERIOR UNITS)**

- A. Unit casings shall be fabricated of heavy gauge steel reinforced with steel angle framework as required for smooth operation for pressure rating. Casings shall be sectionalized with separate fan and coil sections. Units casing shall be of double-wall construction.
- B. Fan and coil sections shall be insulated with 1", 3/4 pound, mat-faced fiberglass blanket insulation.
- C. Casings shall have removable panels to provide access to all internal components.
- D. IAQ drain pans shall be provided under the complete coil section and double pitched to the drain connection to promote positive drainage. Drain pans shall be double-wall insulated.

### **2.3 CASINGS (EXTERIOR UNITS)**

- A. Unit panels shall be solid double wall construction with insulation of minimum R-12. Exterior panels shall be galvanized steel. All panels shall be fabricated of heavy gauge steel reinforced with steel angle framework as required for smooth operation for pressure rating. Casings shall be sectionalized with separate fan and coil sections.
- B. Unit design shall allow unit to be installed on roof curb. Entire base of unit shall be sealed water tight. Provide unit with roof curb.
- C. Unit exterior shall have enamel finish. Finish shall withstand ASTM B117 salt spray test for a minimum of 500 hrs.
- D. Unit shall be provided with two piece roof. Inner roof shall seal airflow within unit, and have minimum insulation of R-12. Outer roof shall have 1/4"/ft. slope and 2" overhang.
- E. Unit shall be provided with external piping cabinet of the same construction as the unit panels. Piping cabinet shall be provided with access doors.
- F. IAQ drain pans shall be provided under the complete coil section and double pitched to the drain connection to promote positive drainage. Drain pans shall be double-wall insulated.

### **2.4 FANS**

- A. Fans shall be plenumtype.
- B. Bearings shall be grease lubricated ball bearings selected for 200,000 hours average life.
- C. Fans shall be statically and dynamically balanced and factory run tested, in the unit.
- D. Fan and motor assembly shall be internally isolated from unit casing with factory mounted spring isolators. Fan scroll shall be attached to the unit by a flexible canvas duct.
- E. Fan and sheave combinations shall be selected to operate at design conditions without exceeding variable frequency drive speeds of 100 Hz. Combinations requiring operation above 100 Hz are not acceptable. Fan wheel classification must be capable of maximum rpm achievable based on the motor horsepower provided.

### **2.5 COILS**

- A. Coils shall be furnished for heating and/or cooling media as scheduled on the drawings.

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STATION AIR HANDLING UNITS

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- B. Coils shall be aluminum fin, copper tube type. Fins shall have drawn, belled collars bonded to the tubes by means of mechanical expansion of the tubes. Coil casings shall be galvanized steel.
- C. Steam coils shall be non-freeze, double tube, steam distribution type to assure even steam distribution over the full length of each tube.
- D. Hot water heating coils shall be of the metering type with metering orifices in the supply header to insure equal distribution of water to each tube.
- E. Chilled water cooling coils shall be completely drainable, and shall be pitched in the unit casing for proper drainage.

## **2.6 MOTORS AND DRIVES**

- A. Motors shall be NEMA Standard, normal torque, 40 deg. C rise, splash proof, of horsepower rating and electrical characteristics as scheduled on the drawings.
- B. Drives shall be rated at 1.25 times the motor horsepower rating. Drives up to and including 40 horsepower shall be adjustable speed drives (don't use on over 50 HP) for adjustment within plus or minus 10% of specified RPM. Units shall be furnished with approved drive guards.
- C. Motor shall be mounted on an adjustable mount, suitable for adjusting belt tension and drive alignment.

## **2.7 FILTER MODULES**

- A. Filter modules shall be furnished with face area and performance as scheduled on drawings. Modules shall consist of side-access filter racks, access doors, and filter blank-offs. Filter module requirements shall be coordinated with filter media specified in separate section.
- B. 12" Cartridge Filters: Provide Gasketed side-access filter racks suitable to support 12" deep high efficiency cartridge type filters with 7/8" headers.
- C. 12" HEPA Cartridge Filters: Provide Gasketed side-access filter racks suitable to support 12" deep HEPA cartridge type filters.
- D. Gas-Phase Filters: Provide Gasketed side-access filter racks suitable to support activated carbon absorbers with 7/8" headers. Module shall include filter rack for 2" pleated media throw-away pre-filters and post-filters.

## **2.8 FILTER MIXING BOXES**

- A. Combination filter mixing boxes shall have parallel damper blades for internal merging of airstreams. Leaving side shall have bolt holes compatible with unit and other accessories. Mixing box shall be designed to hold 2" pleated throw-away filters, MERV 8A minimum or as scheduled. Provide with full size access door. Dampers shall be low leak type construction with metal compressible jamb seals and extruded vinyl blade edge seals, mechanically locked into the blade edge, on both the outdoor air and return air. Leakage shall not exceed 5 cfm/sf at one-inch wg. All leakage testing and pressure ratings will be based on AMCA Publication 500.

## **2.9 INLET HOOD AND DAMPER**

- A. Provide inlet weatherhood with moisture eliminator and bird screen.

- B. Provide low leak type dampers with metal compressible jamb seals and extruded vinyl blade edge seals. Leakage shall not exceed five cfm per square foot at one-inch wg. All leakage testing and pressure ratings will be based on AMCA Publication 500.

## **2.10 AIR BLENDER**

- A. Manufacturer: Blender Products Inc or approved equal.
  - 1. Units shall be not less than 0.08” aluminum of all welded construction.
  - 2. Units shall be completely fixed devices capable of providing mixed air temperatures within 6°F of theoretical values.
  - 3. Refer to drawings for units that require air blenders.

## **2.11 VARIABLE FREQUENCY DRIVES**

- A. Variable frequency drives (VFDs) to be provided by air handling unit manufacturer. VFDs to be mounted on air handling unit. Where multiple supply fans serve one air handling unit, one VFD shall operate all fans in the fan array. Where multiple return fans serve one air handling unit, one VFD shall operate all fans in the fan array.
- B. Base VFD type on results of IEEE-519 study with minimum configuration as follows (NOTE: total horsepower connected to a VFD shall be used when calculating harmonic mitigating technology, e.g. (4) 15HP fans = 60HP.):
  - 1. Less than 40 HP – 6 pulse drive with 5% reactor.
  - 2. 40HP up to 75HP – 6 pulse drive with 5% reactor and passive harmonic filter or 12 pulse drive.
  - 3. Larger than 75HP – 18 pulse drive or active front end filter.
  - 4. Engineered solution specific to the project requirements that employs harmonic mitigation equipment and is submitted for Engineer approval prior to bidding.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install units and make piping and duct connections as indicated on the drawings.
- B. For units with water heating and/or cooling coils, install balancing cock, pressure and temperature test stations and shut off valve in return lines. In supply line, install shut off valve, and automatic control valve. Install flexible piping connectors at steam coil connections.
- C. Extend condensate drain line to nearest floor drain and elbow into drain. Condensate waste shall be trapped at drain pan, with screwed cleanout plug in low point of trap. Multiple condensate discharges shall be trapped separately, as close to the unit as possible. The effective trap seal shall be two (2) times the suction pressure of the fan in inches for draw through units, but not less than three (3) inches.
- D. Provide equipment base rail or housekeeping pad as required to maintain required height for installation of all piping and ductwork connections to unit including condensate traps.
- E. Provide one complete extra set of filters for each air handling system. If system is designed to include pre-filters and after-filters, provide only pre-filters. Install new filters at completion of air handling system and prior to testing, adjusting and balancing work. Obtain receipt from Owner that new filters have been installed.

**END OF SECTION 23 74 13**

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## SECTION 23 81 28 – DUCTLESS SPLIT SYSTEM AIR CONDITIONERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of split system air conditioner work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of equipment in this section include the following:
  - 1. Air cooled condensing units.
  - 2. Heat pump terminal units.
- C. Refer to other Division 23 sections for piping, refrigeration specialties, etc., required external to condensing units for installation; not work of this section.
- D. Refer to Division 26 sections for field installed power wiring required for condensing units; not work of this section.

#### 1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. AHRI Compliance: Provide capacity ratings for condensing units in accordance with Air Conditioning, Heating, and Refrigeration Institute (ARI) Standard 240 "Performance Rating for Unitary Air Conditioning and Air Source Heat Pump Equipment".
  - 2. ASHRAE Compliance: Construct refrigerating system of condensing units in accordance with American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard ANSI/ASHRAE 15, "Safety Code for Mechanical Refrigeration".
  - 3. UL Compliance: Provide condensing units which are listed by Underwriters Laboratories (UL) and have UL label affixed.
- B. Warranty:
  - 1. Provide one-year warranty on all parts except compressor.
  - 2. Provide five-year warranty on compressor.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's equipment specifications, equipment capacities, ratings and selection points and installation and start up instructions.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances and method of assembly of components.

- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

## **1.5 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Handle condensing units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged condensing units or components; replace with new.
- B. Store condensing units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Air cooled Condensing Units and Terminal Units
  - 1. Mitsubishi
  - 2. LG
  - 3. Daikin
  - 4. Samsung
  - 5. Lennox

### **2.2 GENERAL**

- A. Provide factory assembled and tested air cooled condensing units and heat pumps as indicated, consisting of compressor, condenser coil, fan, motor, refrigerant reservoir, and operating controls. Provide capacity and electrical characteristics as scheduled.

### **2.3 TERMINAL UNITS**

- A. General:
  - 1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board, fan and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. The indoor unit shall be charged with dry air before shipment from factory.
- B. Unit Cabinet:
  - 1. The cabinet shall be galvanized steel construction, low profile, horizontal ducted fan coil equipped with four corner mounting brackets.
- C. Fan:
  - 1. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
  - 2. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus Auto Fan Mode
  - 3. The indoor unit shall have a ducted air outlet system and ducted return air system.
- D. Filter:
  - 1. Return air shall be filtered by means of a standard factory installed return air filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 21 – 11/16 inches above the condensate pan.
7. A drain pan level switch (DPLS1), designed to connect to the control board, shall be provided and installed on the condensate pan to prevent condensate from overflowing.
8. Both refrigerant lines to the indoor units shall be fully insulated.

F. Electrical:

1. The system shall be equipped with A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14 gauge AWG connection plus ground.

G. Controls:

1. The control system shall consist of a minimum of one microprocessor on each indoor unit and one in the outdoor unit, communicating via A-Control data over power transmission. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired or wireless controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.
2. For A-Control, a three (3) conductor 14 gauge AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.
3. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
4. Remote Controller
  - a. Wired Remote Controller

The Wired Remote Controller shall have a built-in weekly timer with up to 8 pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in Fahrenheit (°F) and Temperature changes shall be by increments of 1°F (0.5°C).

Field wiring shall run directly from the indoor unit to the wired controller with no splices. The control voltage from the wired controller to the indoor unit shall be 12/24 volts, DC. Up to two wired controllers shall be able to be used to control one unit.

- b. **Wireless, handheld remote controller (PAR-FL32MA)**  
The wireless had held remote controller (PAR-FL32MA) shall be used with a wireless receiver (PAR-FA32MA-E). The controller shall perform input functions necessary to operate the system. The wireless receiver shall be plug and fit compatible with the indoor unit.  
  
The controller shall have a Power On/Off switch, Mode Selector – Cool, Dry, Heat, Auto, and Powerful Modes - Temperature Setting, Timer Control and Fan Speed Selector. The indoor unit shall perform Self-diagnostic Function and Check Mode switching. Temperature changes shall be in 1°F (0.5°C) increments with a setting range of 61 to 88°F (16 to 31°C).

## **2.4      2.04    OUTDOOR CONDENSING UNITS**

- A. **General:**
  - 1. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.
- B. **Unit Cabinet:**
  - 1. The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Assembly hardware shall be cadmium plated for weather resistance.
  - 2. Two (2) mild steel mounting feet, traverse mounted across the cabinet base pan, welded mount, providing four (4) slotted mounting holes shall be furnished. Assembly shall withstand lateral wind gust up to 155 MPH to meet applicable weather codes.
- C. **Fan:**
  - 1. The unit shall be furnished with a direct drive, high performance propeller type fan.
  - 2. The condenser fan motor shall be a variable speed, direct current (DC) motor and shall have permanently lubricated bearings.
  - 3. Fan speed shall switch automatically according to the number of operating indoor units and the compressor operating frequency.
  - 4. The fan motor shall be mounted with vibration isolation for quiet operation.
  - 5. The fan shall be provided with a raised guard to prevent contact with moving parts.
  - 6. The outdoor unit shall have horizontal discharge airflow.
- D. **Coil:**
  - 1. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
  - 2. The coil shall be protected with an integral guard.
  - 3. Refrigerant flow from the outdoor unit to the indoor units shall be independently controlled by means of individual electronic linear expansion valves for each indoor unit.
  - 4. Outdoor unit shall be pre-charged with sufficient R-410a refrigerant for up to twenty five (25) feet of refrigerant piping.



5. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.
  6. All refrigerant connections between outdoor and indoor units shall be flare type.
- E. Compressor:
1. The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type.
  2. The compressor motor shall be direct current (DC) type equipped with a factory supplied and installed inverter drive package.
  3. The outdoor unit shall be equipped with a suction side refrigerant accumulator.
  4. The compressor will be equipped with an internal thermal overload.
  5. The compressor shall be mounted so as to avoid the transmission of vibration.
- F. Electrical:
1. The outdoor unit shall be controlled by the microprocessors located in the indoor unit and in the outdoor unit communicating system status, operation, and instructions digitally over A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14 gauge AWG connection plus ground. A 12 to 24 volt DC data stream shall communicate between the units providing all necessary information for full function control.
  2. The outdoor unit shall be equipped with Pulse Amplitude Modulation (PAM) compressor inverter drive control for maximum efficiency with minimum power consumption.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine areas and conditions under which condensing units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

#### **3.2 INSTALLATION OF CONDENSING UNITS**

- A. General: Install condensing units and heat pump terminal units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Install ground mounted units on 4" thick reinforced concrete pad, 4" larger on each side than condensing unit. Anchor unit to pad using inserts or anchor bolts.
- C. Electrical: Furnish electrical field wiring diagrams to Electrical Contractor for power wiring to condensing units.
- D. Air Cooled Condensing Units: Connect refrigerant piping to unit; run piping so as to not interfere with access to unit.
1. Install furnished field mounted accessories.

2. Refrigerant piping shall be insulated in accordance with the requirements of this section and Section 23 0700 - HVAC Insulation.
  3. Install flexible piping connection for units mounted on spring isolators.
- E. Start up condensing units, in accordance with manufacturer's start up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

**3.3 TRAINING OF OWNER'S PERSONNEL**

- A. Instruct Owner's personnel in operation and maintenance of condensing units.

**END OF SECTION 23 81 28**

## SECTION 23 82 16 - AIR COILS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install air coils as required by the drawings and this section.
- B. Types of air coils specified in this section include the following:
  - 1. Cooling and Heating Coils
  - 2. Reheat Coils

#### 1.3 QUALITY ASSURANCE

- A. ARI Compliance: Units shall have certified ratings complying with ARI Standard 410.

#### 1.4 SUBMITTALS

- A. Submittal data shall consist of drawings and/or catalog cuts giving dimensions, arrangement, construction materials, coil capacity and installation instructions.

#### 1.5 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Cooling and Heating Coils
  - 1. Airtherm
  - 2. Daikin Applied
  - 3. Heatcraft
  - 4. Trane
  - 5. USA Coil and Air
  - 6. JCI
  - 7. Precision
  - 8. Aerofin

- B. Reheat Coils
  - 1. Airtherm
  - 2. Daikin Applied
  - 3. JCI
  - 4. Trane
  - 5. Heatcraft
  - 6. Precision
  - 7. Aerofin

## **2.2 COOLING AND HEATING COILS**

- A. Coils shall be furnished for heating and/or cooling media as scheduled on the drawings.
- B. Coils shall be aluminum fin, copper tube type. Fins shall have drawn, belled collars bonded to the tubes by means of mechanical expansion of the tubes. Coil casings shall be galvanized steel.
- C. Steam coils shall be non-freeze, double tube, steam distribution type to assure even steam distribution over the full length of each tube.
- D. Hot water heating coils shall be of the metering type with metering orifices in the supply header to insure equal distribution of water to each tube.
- E. Chilled water cooling coils shall be completely drainable, and shall be pitched in the unit casing for proper drainage.
- F. Coils shall be completely drainable, and shall be pitched for proper drainage.

## **2.3 REHEAT COILS**

- A. Coils shall have capacities and ratings and shall be of the type as scheduled on the drawings.
- B. Coils shall consist of seamless copper tubes mechanically bonded to aluminum fins. Maximum working pressure 225 psig.
- C. Coils shall be provided with slip flange for duct mounting.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install coils and make piping and duct connections as indicated on the drawings. Multi-row coils to be installed in counterflow arrangement relative to airflow.

**END OF SECTION 23 82 16**

## SECTION 23 82 19 - FAN COIL UNITS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this Section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install fan coil units as required by the drawings and this section.

#### 1.3 SUBMITTALS

- A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the terminal units.

#### 1.4 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Fan Coil Units
  - 1. Airtherm
  - 2. Daikin Applied
  - 3. Trane Co., Inc.
  - 4. Enviro-Tec
  - 5. Rittling

#### 2.2 FAN COIL

- A. Units shall have capacities and ratings and shall be of arrangement as scheduled on the drawings.
- B. Units shall be furnished complete with coils, enclosures, drain pans, fans and motors as required to make complete functioning units. Structural frame and panels shall be fabricated from minimum 18 ga. galvanized steel, and all steel parts exposed to moisture shall be galvanized. Drain pans shall be positively sloped (multi-plane) and insulated with closed cell insulation. Unit casing shall be acoustically and thermally insulated with closed cell insulation.

- C. Units to be installed in finished areas to be furnished with bonderized, phosphatized, flow coated baked on primer with spray applied baked on enamels in color as selected by Design Professional from manufacturer's standard colors.
- D. Coils shall consist of seamless copper tubes mechanically bonded to aluminum fins.
- E. Motors:
  - 1. Motors shall be brushless DC Electronically Commutated Motors (ECM) factory programmed and run tested in assembled units.
  - 2. Provide speed switch for control of motor to three different speeds; console unit to be provided with a unit mounted switch, ceiling mounted units to be provided with a wall mounted switch.
  - 3. Provide motor controller with contacts to receive 0-10V DC input from the Building Automation System for control of the motor speed.
  - 4. Motors shall have integral thermal overload protection with a maximum ambient operating temperature of 104F and shall be permanently lubricated.
- F. 1" throw away type filters shall be concealed from sight and easily removable.
- G. Provide with a unit mounted, non-fused disconnect switch.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install units and make duct and piping connection as indicated on drawings.
- B. Install shut off cocks, balancing cocks, air vents, control valves and devices as required for complete installation.
- C. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.
  - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start up until wiring installation is acceptable to equipment installer.

**END OF SECTION 23 82 19**

## SECTION 23 82 33 – CONVECTORS AND RADIANT HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install terminal units as required by the drawings and this section.
- B. This section includes the following:
  - 1. Finned Tube Radiation and Convectors
  - 2. Radiators
  - 3. Radiant Ceiling Panels
  - 4. Electric Baseboard Heaters

#### 1.3 SUBMITTALS

- A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the equipment.

#### 1.4 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Finned Tube Radiation and Convectors
  - 1. Vulcan
  - 2. Airtherm
  - 3. American Air Filter
  - 4. Rittling
  - 5. Sterling Radiator
- B. Radiant Ceiling Panels
  - 1. Aerotech Mfg. Inc.
  - 2. Airtex / Airtite

3. Sigma
4. Rittling

## 2.2 CONVECTORS AND FINNED TUBE RADIATION

- A. Units shall have capacities and ratings and shall be of arrangement as scheduled on the drawings.
- B. Units shall be furnished complete with coils and enclosures as required to make complete functioning units.
- C. Units to be installed in finished areas to be furnished with bonderized, phosphatized, flow coated baked on primer with spray applied baked on enamels in color as selected by Design Professional.
- D. Coils shall consist of seamless copper tubes mechanically bonded to aluminum fins. Maximum working pressure 125 psig and test pressure of 300 psig.

## 2.3 RADIANT CEILING PANELS

- A. Quality Assurance
  1. Certify pressure drops and capacities in accordance with manufacturer's test procedure.
  2. Pressure test each panel to 150 psi.
  3. Manufacturer to have similar installation in operation for more than three years.
- B. Panel Construction
  1. Extruded Aluminum AXO Panels:
    - a. Extrusion panel thickness approximately 0.100".
    - b. Panel Tube: 0.500" I.D. copper.
    - c. Panels have a "U" shaped channel on the back of the extrusion into which the copper tube is inserted. The "U" shaped channel is then formed more than 3/4th of the way around the copper tube for increased thermal performance and to eliminate any separation of copper and aluminum. The use of adhesive or hold-down clips to attach copper tubing to the aluminum extrusion is not acceptable.
    - d. Panels shall be factory assembled from multiples of 5", 6" or 8" extrusions.
      - 1) Return bends factory installed.
      - 2) Cross bar to maintain flatness and provide anchor point for panel suspension.
      - 3) Alligator type spring clips for joining extrusions are not acceptable.
      - 4) Apply two coats baked enamel paint only to the finished side of panels after assembly. Paint on plenum side of panel not acceptable.
      - 5) Maximum length, 16 feet.
    - e. Face configuration: V-Groove or Fluted.
    - f. Panel heating performance shall be as scheduled.
  2. Interconnecting Tube:
    - a. Type "L" copper, 3/8" (0.500 OD), or type "M" hard copper 1/2" nominal (0.625 OD) 0.028" wall thickness.
    - b. Solder: [50/50] tin-lead or [95/5] tin antimony.
  3. Insulation:
    - a. Fiberglass: 3/4 pound per cubic foot density.
    - b. Thickness: 1" nominal.



## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install units and make piping connection as indicated on drawings.
- B. Install shut off cocks, balancing cocks, air vents, control valves and devices as required for complete installation.
- C. All finned tube enclosures five feet long or greater to be provided with control valve access panel.
- D. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.
  - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start up until wiring installation is acceptable to equipment installer.

### **3.2 RADIANT CEILING PANELS**

- A. Installation of panels in ceiling shall be by factory trained technicians.
- B. Schedule and coordinate work with ceiling installer and piping installer so that the construction sequence will provide for the best overall appearance of the installation.
- C. Suspend panels with galvanized, soft-annealed steel wire, 12 ga. Spacing of supports shall not exceed four feet on center.
- D. HVAC contractor is responsible for installation of insulation over top of radiant ceiling panels in accordance with panel manufacturer's recommendations.

**END OF SECTION 23 82 33**

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## SECTION 23 82 39 - UNIT HEATERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 23 00 10 - HVAC General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide material, equipment, labor and supervision necessary to install unit heaters as required by the drawings and this section.

#### 1.3 UNIT HEATERS

- A. Unit heaters shall include the following:
  - 1. Hydronic Unit Heaters
  - 2. Electric Unit Heaters and Cabinet Unit Heaters

#### 1.4 SUBMITTALS

- A. Submit shop drawings and/or catalog cuts showing technical data necessary to evaluate the equipment, to include color charts, dimensions, wiring diagrams, performance data and other descriptive data necessary to describe fully the terminal units.

#### 1.5 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 for detailed commissioning requirements.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Hydronic Unit Heaters and Cabinet Unit Heaters
  - 1. Airtherm
  - 2. Trane
  - 3. Daikin Applied
  - 4. Modine
  - 5. Vulcan
  - 6. Sterling
  - 7. Rittling
  - 8. Sigma
  - 9. Redd-I
  - 10. Johnson Controls

B. Electric Unit Heaters and Cabinet Unit Heaters

1. Trane
2. Berko - (Division of Marley)
3. Q-mark - (Division of Marley)
4. Brasch
5. Indeeco
6. King Electric
7. Raywall
8. Redd-I
9. Heatrex

**2.2 HYDRONIC UNIT HEATERS AND CABINET UNIT HEATERS**

- A. Units shall have capacities and ratings and shall be of arrangement as scheduled on the drawings.
- B. Units shall be furnished complete with coils, enclosures, drain pans, fans and motors as required to make complete functioning units.
- C. Units to be installed in finished areas to be furnished with bonderized, phosphatized, flow coated baked on primer with spray applied baked on enamels in color as selected by Design Professional.
- D. Coils shall consist of seamless copper tubes mechanically bonded to aluminum fins. Maximum working pressure 125 psig and test pressure of 300 psig.
- E. Motors for unit heaters shall be totally enclosed, Class 'B' insulation, with built in overload protection, and shall be prewired to terminal strip in factory mounted junction box.
- F. Motors for cabinet unit heaters shall be brushless DC Electrically Commutated Motors (ECM) factory programmed and run tested in assembled units.
  1. Motors shall have integral thermal overload protection with a maximum ambient operating temperature of 104F and shall be permanently lubricated.
  2. Provide speed switch for control of motor to three different speeds; console units to be provided with a unit mounted switch, ceiling units to be provided with a wall mounted switch.
  3. Provide motor controller with contacts to receive 0-10V DC input from the Building Automation System for control of the motor speed.
- G. Filters for cabinet unit heaters shall have 1" thick woven glass replaceable media, and permanent aluminum frames.

**2.3 ELECTRIC UNIT HEATERS**

- A. Units shall have capacities and ratings and shall be of arrangement as scheduled on the drawings.
- B. Units shall be furnished complete with coils, enclosures, fans and motors as required to make complete functioning units.
- C. Units to be installed in finished areas to be furnished with bonderized, phosphatized, flow coated baked on primer with spray applied baked on enamels in color as selected by Design Professional from the manufacturer's standard offering.

- D. Motors for unit heaters and cabinet unit heaters shall be totally enclosed, Class 'B' insulation, with built in overload protection, and shall be prewired to terminal strip in factory mounted junction box.
- E. Filters for cabinet unit heaters shall have 1" thick woven glass replaceable media, and permanent aluminum frames.
- F. Units shall have single point, line voltage connection for incoming power for 208, 240 or 480 volt services.
- G. Provide the following accessories:
  - 1. Thermostat with external adjustable knob.
  - 2. Three position fan selector switch.
  - 3. Pilot light to indicate when heating elements are energized.
  - 4. Disconnect switch.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install units and make duct and piping connection as indicated on drawings.
- B. Install shut off cocks, balancing cocks, air vents, control valves and devices as required for complete installation.
- C. Controls: Install devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor for power wiring.
  - 1. Verify that wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start up until wiring installation is acceptable to equipment installer.

**END OF SECTION 23 82 39**

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**DIVISION 26**





## SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

#### 1.2 DESCRIPTION OF WORK

- A. Work shall include furnishing of all systems, equipment and material specified in this division and as called for on the electrical drawings, to include supervision, operations, methods and labor for the fabrication, installation, start-up and tests for the complete electrical installation. Include all provisions necessary for complete installation and proper operation of systems and components.
- B. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft in accordance with ANSI/NECA 1 standards.
- C. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft and in collaboration and coordination with other trades. Adjust work as necessary to avoid interference with other trades. Refer to contract documents and submittals for other trades such as Mechanical, Plumbing, Architectural for equipment being furnished as part of their scopes of work but requiring electrical connections.
- D. Definitions for “provide”, “furnish” and “install”.
  - 1. “Provide” = furnish and install
  - 2. “Furnish” = does not include installation.
  - 3. “Install” = does not include furnishing.
- E. Do not scale drawings for dimensional purposes.
- F. Refer to Architectural and Civil Landscape Drawings for final device locations and other features that may impact electrical work.
- G. Provide demolition as necessary to perform new work.
- H. Refer to Division 2 for Selective and General Demolition requirements.
- I. Security system infrastructure
  - 1. Refer to SC series sheets. Provide all conduits, cables, pathways, supports, power circuits, data connections, etc. required for installation of the security system. System will include intercom stations, door control system, door locking hardware, touch screen controls, proximity readers, etc.
- J. AV system infrastructure
  - 1. Refer to AV series sheets. Provide all conduits, cables, pathways, supports, power circuits, data connections, etc. including scheduled boxes on AV901 required for installation of the audio-visual system. System will included audio speakers, digital displays, AV equipment racks, audio and video equipment, touch screen controls, etc.

K. Temporary Generators and Services

1. Provide temporary generators to support spaces required to remain operational during construction when normal power is not available.
2. Provide temporary service to support cooling systems when normal power is not available or where onsite capacity does not exist.

**1.3 CODES AND STANDARDS**

A. All work shall be done in accordance with the applicable portion of the following codes and standards:

1. National Electrical Code (NEC)
2. National Electrical Safety Code (NESC)
3. National Fire Protection Association (NFPA)
4. National Electrical Manufacturers Association (NEMA)
5. Standards of Institute of Electrical and Electronic Engineers (IEEE)
6. International Building Code (IBC)
7. Occupational Safety and Health Act (OSHA)
8. Wisconsin Enrolled Commercial Building Code
9. National Electrical Contractors Association (NECA) Standards
10. National Electrical Testing Association (NETA)
11. Americans With Disabilities Act (ADA)
12. Illuminating Engineering Society of North America (IESNA)
13. American National Standards Institute (ANSI)
14. Underwriter's Laboratories (UL)
15. Telecommunications Industries Association (TIA)
16. Federal Communication Commission (FCC)

B. All Contractors shall familiarize themselves with all codes and standards applicable to their work and shall notify Design Professional of any discrepancies between the design and applicable code requirements so that any conflicts can be resolved. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

**1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES**

A. Federal, State, local authority and utility requirements in force at time of execution of this project shall be part of the specifications.

B. Contractor shall comply with the rules and regulations of the local utility companies. Contractor shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.

C. Secure all required permits and pay for all inspections, licenses and fees required in connection with the electrical work including State of Wisconsin Electrical Inspections. Contractor shall post all bonds and obtain all licenses required by the State, City, County and Utility.

**1.5 ELECTRICAL DRAWINGS**

A. The electrical drawings indicate in general the building arrangement only. Contractor shall examine construction drawings to become familiar with the specific type of building construction, i.e. type of structural system, floors, walls, ceilings, room finishes and elevations.

- B. Drawings for the electrical work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
- C. Contractor shall layout their own work and shall be responsible for determining the exact locations for equipment and rough-ins and the exact routing of conduits and raceway so as to best fit the layout of the work.
- D. Contractor shall take their own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- E. Because of the scale of the drawings, certain basic items such as couplings, pull or splice boxes may not be shown, but where such items are required by code or by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.

#### **1.6 ACTIVE SERVICES**

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.
- B. Existing active services, i.e., water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain.
- C. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
  - 1. Obtain written permission from Owner and Architect prior to interrupting any service. Timing of interruption shall be at the discretion of the Owner and may require after hours or weekend work.
- D. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

#### **1.7 TEMPORARY SERVICES**

- A. Refer to Specification Division 1 for specific requirements concerning temporary utilities.

#### **1.8 SITE INSPECTION**

- A. Contractor shall inspect the site prior to submitting bid for work to get familiar with the conditions of the site which will affect their work and shall verify points of connection with utilities, routing of outside conduit to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

#### **1.9 COORDINATION AND COOPERATION**

- A. It shall be Contractor's responsibility to schedule and coordinate their work with the schedule of the General Contractor to progress the work expeditiously, and to avoid unnecessary delays.

- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of their work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to their equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Conflicts between the drawings and the specifications or between the requirements set forth for the various contractors shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and their decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided. Refer to Division 09 for painting protection.
- F. Where the final installation or connection of equipment in the building requires the contractor to work in areas previously finished by the General Contractor, the Electrical Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Electrical Contractor shall arrange with the General Contractor for patching and refinishing of such areas which may be damaged in this respect.
- G. Refer to 00 and/or 01 for requirements related to coordination drawings between trades. Contractor shall participate in the coordination process and development of the coordination drawings as specified.

#### **1.10 OPENINGS, CUTTING AND PATCHING**

- A. Refer to Division 1 for additional cutting and patching information.
- B. Conduits and sleeves passing through all fire or smoke rated floors, roofs, walls, and partitions shall be provided with firestopping. Space between wall/floor and conduit or sleeve shall be sealed with UL listed intumescent fire barrier material equivalent to rating of wall/floor. Where conduit or sleeves pass through floors, roofs, walls and partitions that are not fire or smoke rated, penetrations shall be sealed with grout or caulk.
- C. New structure:
  1. Contractor will coordinate the placing of openings and lintels in the new structure as required for the installation of the electrical work with the General Contractor.
  2. Contractor shall furnish to General Contractor the accurate locations and sizes for required openings, but this shall not relieve Contractor of the responsibility of checking to assure that proper size openings are provided. When additional cutting and patching is required due to Contractor's failure to coordinate this work, Contractor shall make arrangements for the cutting, patching, and painting required.

- D. Existing Structure:
1. Contractor shall provide cutting, lintels and patching, and patch painting in the existing structure, as required for the installation of their work, and shall furnish lintels and supports as required for openings.
  2. Cutting of structural support members will not be permitted without prior approval of the Design Professional. Extent of cutting shall be minimized; use core drills, power saws or other machines which will provide neat, minimum openings.
  3. Patching shall match adjacent materials and surfaces and shall be performed by craftsmen skilled in the respective craft required.
- E. For exterior walls below grade, sleeves shall be cast iron. Space between sleeve and conduit shall be sealed with modular mechanical rubber links tightened with bolts as made by Thunderline Corporation, Wayne, Michigan 48184. Waterproofing of conduit penetrations in exterior walls shall be coordinated with waterproofing contractor.
- F. Roof penetrations and sleeves: Seal penetrations or individual raceways with flexible boot-type flashing units applied in coordination with roofing work.
- G. Do not pierce structural elements such as floors, beams or columns without prior permission from Architect. Submit for Structural Engineer review all core drilled hole locations or other structural penetrations that may be required prior to execution of work.
- H. Seal penetrations through fire-rated assemblies with UL listed fire stopping system matching installation requirements per fire stopping manufacturer.
- I. Repair, replace or refinish surfaces such as lawns, paving, etc. to match existing conditions prior to commencement of work.
- J. Provide chrome escutcheons to match raceway size where raceways pass through walls, floors or ceilings in public areas.

#### **1.11 EXCAVATING AND BACKFILLING**

- A. Contractor shall do all excavating necessary for lightpole bases, underground wiring, conduit and duct banks, and shall backfill trenches and excavations after work has been inspected. Care shall be taken in excavating that walls and footings and adjacent load bearing soils are not disturbed in any way, except where lines must cross under a wall footing. Where a line must pass under a footing, the crossing shall be made by the smallest possible trench to accommodate the conduit. Excavation shall be kept free from water by pumping if necessary.
- B. Backfill about the structure shall be placed, when practical, as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit. Backfill shall be in accordance with Specification Division 31.
- B. Backfill about the structures shall be placed, when practicable as the work of construction progresses. Backfilling on or against concrete work shall be done only when directed. Backfilling of trenches shall progress as rapidly as the testing and acceptance of the finished sections of the work will permit in accordance with Specification Division 31. Backfilling shall be carried to a crown approximately six (6) inches above the existing grades. In backfilling trenches, selected material shall be compacted firmly around and to a depth of not less than six (6) inches over the top of work in trench. All fill and backfill and rough grading shall be compacted thoroughly in layers and shall be brought up to within six (6) inches of finished grades. All fill and backfill shall be sand or pit run sand/gravel graded from 1" size downward.

**1.12 MATERIALS AND EQUIPMENT**

- A. All materials and equipment shall be the standard product of a reputable U.S.A. manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same system, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.
- D. Provide materials that are UL listed or bear the UL mark unless the specific class of material(s) is not available with such listings. Other nationally recognized testing agencies identified as acceptable to the AHJ are acceptable.
- E. Furnish equipment with factory-applied finish coats. If equipment finish is damaged during shipment, acquire manufacturer's finish products for field touchups to satisfaction of Architect/Engineer.

**1.13 SUBMITTALS**

- A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- D. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.
- E. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	PROD SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
26 05 19	Low-Voltage Power Conductors and Cables		X			X		
26 05 33	Raceway and Boxes for Electrical Systems		X			X		
26 05 73	Short Circuit-Coordination Study/Arc Flash Hazard Analysis		X			X		1
26 09 23	Lighting Control Systems	X	X			X	X	

26 22 00	Low-Voltage Transformers	X	X			X	X	
26 24 13	Switchboards	X	X			X	X	
26 24 16	Panelboards	X	X			X	X	
26 24 19	Motor-Control Centers	X	X			X	X	
26 27 26	Wiring Devices		X			X		
26 28 16	Enclosed Switches and Circuit Breakers		X			X	X	
	Fuses		X			X		
	Overload Relays		X			X		
26 29 13	Motor Starters		X			X	X	
26 29 23	Variable Frequency Motor Controllers		X			X	X	
26 32 13	Engine Generators	X	X			X	X	
26 33 23	Central Battery Equipment		X			X	X	
26 36 00	Transfer Switch		X			X	X	
26 43 13	Surge Protective Devices		X			X		
26 50 00	Lighting	X	X			X	X	

NOTES:

1. Provide preliminary report; refer to specification section for requirements.

- F. Identify proposed materials and equipment being submitted on general catalog sheets. Indicate specific name or number of equipment being submitted as it relates to specifications or drawings.
- G. Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications. Submittals must be reviewed before installation of equipment or materials.
- H. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.
- I. Where identified in the individual specification section, submit line by line compliance review of specification relative to equipment and materials being submitted. Each line item shall be marked with "C", "D" or "E" in the margin of the specification. "C" indicates compliance with no exceptions. "D" indicates compliance with deviations with reasoning for deviation. "E" indicates non-compliance due to exceptions.
- J. Submitted documents greater than 50 pages shall include electronic bookmarks for navigation. Each subsection shall include a bookmark.

#### 1.14 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted to Design Professional. Refer to Division 01 specifications for additional information.

- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three ring hard-backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION  
AND  
MAINTENANCE  
MANUAL  
FOR  
ELECTRICAL SYSTEMS

(PROJECT NAME)  
(LOCATION)  
(DATE)

SUBMITTED BY  
(NAME AND ADDRESS OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Use plastic tab indexes for sections of manual. Each section shall contain the following information for equipment furnished under this contract:
1. Equipment and system warranties and guarantees.
  2. Installation instructions.
  3. Operating instructions.
  4. Maintenance instructions.
  5. Spare parts identification and ordering list.
  6. Local service organization, address, contact and phone number.
  7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.
- D. Items to be included shall be those listed in shop drawing section.

#### **1.15 RECORD DOCUMENTS**

- A. Refer to Division 1 for Record Document Requirements.
- B. Markup set of Contract Documents with final installed field conditions.

#### **1.16 SUBSTITUTIONS**

- A. Refer to Divisions 00 and 01. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent. between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.



### **1.17 ACCEPTABLE MANUFACTURERS**

In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plan schedules are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.

Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.

- A. If Contractor chooses to use a manufacturer listed as an equal, it shall be their responsibility to assure that the manufacturer has complied with the requirements in *SUBSTITUTIONS 'A'* above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- B. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

### **1.18 WARRANTY**

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
  - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
    - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
    - b. The entire Electrical system, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 26 sections for systems, equipment, or material requiring extended warranties beyond one year.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

### **1.19 CHANGES IN THE WORK**

- A. Refer to Divisions 00 and 01.

## **1.20 COMPLETION**

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by the Owner.
- B. When all the electrical work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

## **1.21 ACCESS DOORS**

- A. When the Electrical Contractor provides any equipment requiring periodic servicing which will be concealed by non-accessible architectural construction, the Electrical Contractor shall notify General Contractor who will provide an access door. Refer to Section 08 3100 – Access Doors and Panels. The use of access doors should be minimized wherever possible.

## **1.22 CONCRETE EQUIPMENT PADS**

- A. Provide equipment housekeeping pads for all floor mounted equipment. Anchor equipment to concrete equipment pads according to equipment manufacturer's recommendations.
  - 1. Construct concrete bases of dimensions indicated or as required to be 4 inches larger in both directions than supported unit. Pads to be a minimum of 4" in height unless noted otherwise.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts according to manufacturer's recommendations and to elevations required for proper attachment to supported equipment.
  - 6. Use minimum 3000-psi compressive strength concrete with #3 rebar 12" O.C. in accordance with Division 03 – Concrete.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS FOR DEMOLITION**

- A. All materials removed shall be the property of the removing contractor and shall be removed from the site unless otherwise specified. Contractor shall remove and turnover devices, equipment, etc. identified by the Owner to be retained.

## **PART 3 - EXECUTION**

### **3.1 GENERAL DEMOLITION**

- A. Demolition shall be accomplished by the proper tools and equipment for the work to be removed. Personnel shall be experienced and qualified in the type of work to be performed.

B. Examination

1. Verify field measurements and circuiting arrangements are as shown on Drawings.
2. Verify that abandoned wiring and equipment serve only abandoned facilities.
3. Demolition Drawings are based on casual field observation. Report discrepancies to Owner before disturbing existing installation.

C. Preparation

1. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
2. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
3. Existing Electrical Services: Maintain existing system in service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
4. Existing Fire Alarm System: Maintain existing system in service. Disable system only to make switchovers and connections. Notify Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
5. Existing Telecommunications Systems: Maintain existing systems in service. Disable systems only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system.

D. Demolition and Extension of Existing Electrical Work

1. Demolish and extend existing electrical work under provisions of this Section.
2. Remove, relocate, and extend existing installations to accommodate new construction. Extend existing installations using materials and methods as specified.
3. Remove abandoned wiring to source of supply.
4. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
5. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
6. Disconnect and remove abandoned panelboards and distribution equipment.
7. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
8. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
9. Repair adjacent construction and finishes damaged during demolition and extension work.
10. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
11. Clean and repair existing materials and equipment which remain or are to be reused.

E. Fluorescent Lamp and Ballast Disposal

1. Unless noted otherwise, all existing fluorescent lamps and ballasts within light fixtures to be removed shall be assumed to contain mercury and PCB's respectively. These items need to be disposed of by a mercury and PCB Disposal Contractor, who shall be a subcontractor to Electrical Contractor. This Disposal Contractor shall have all local, state, and federal authorization for handling, transporting, and processing these materials. Disposal Contractor shall have pollution insurance and shall generate a Certificate of Disposal. Ballasts and all contaminated materials shall be incinerated. Lamps shall be recycled.

F. Work by Others

1. Unless specifically noted under other contracts, Division 26 Contractor shall assume all required work shall be performed as part of this scope. In general, the following will be performed by others:
  - a. Division 1 Contractor will remove any bases, floor fill, wall work and footings; neatly patch, match, complete and finish all affected surfaces.
  - b. Division 23 Contractor will disconnect all mechanical services and remove pipe back to behind finish surfaces, close and cap ends of pipe.

G. Cleaning and Repair of Existing Components

1. Clean and repair existing equipment and materials that will remain or be reused. Replace damaged components where necessary.
2. Clean exposed surfaces and re-torque all electrical connections.
3. Revise panel circuit directories for panelboards that are used to serve new loads.
4. Remove existing luminaires and clean all surfaces prior to reinstallation.

H. Owner's Right of Salvage

1. Owner may designate and have salvage rights to any material herein demolished by the Contractor. Turnover all materials to be salvaged at a place and time designated by Owner. Maintain condition of salvaged materials for re-use. Repair or replace damaged materials at no additional cost to Owner. Remove and dispose all materials that are not identified to be salvaged.

**3.2 START-UP, TESTS AND DEMONSTRATIONS**

- A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner. Notify Owner, Architect, Engineer or Inspector at least 10 days prior to beginning testing.
- B. Follow manufacturer's instructions for start-up and adjustment. Contractor shall provide services from a factory certified representative where specified or contractor does not have qualified personnel.
- C. Contractor shall test the electrical grounding system resistance in accordance with Specification Section 26 05 26 – Grounding and Bonding for Electrical Systems and submit a report to Design Professional stating the results.
- D. Prior to acceptance of the electrical installation, the Contractor shall demonstrate to the Owner, or their designated representatives, all essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems. Owner instruction shall be provided for the following systems:

Sections	Description	Hrs. on Site	Hrs. off Site	Presented By	Others Present	Remarks
26 22 00	Electrical Dist. System	4		Contractor		
26 24 13						
26 24 16						
26 24 19						
26 28 15						

Sections	Description	Hrs. on Site	Hrs. off Site	Presented By	Others Present	Remarks
26 29 13 26 24 19	Motor Controls	2		Contractor		
26 32 13 26 36 00	Emergency Generator	4		Manufacturer's Representative	Contractor	1
26 09 23 26 50 00	Building Lighting Controls	6		Manufacturer's Representative	Contractor	
REMARKS:						
<ol style="list-style-type: none"> <li>1. Perform complete system test at time of instruction.</li> <li>2. Refer to 26 09 23 for training requirements.</li> <li>3. Any unused hours shall be used at Owner's discretion during the first year of occupancy.</li> </ol>						

- E. Contractor shall submit to the Design Professional a certificate signed by the Owner stating the date, time, and persons instructed and that the instruction has been completed to the Owner's satisfaction. An example of a certificate form is as follows:

**CERTIFICATE OF SYSTEM DEMONSTRATION**

This document is to certify that the contractor has demonstrated the hereafter listed systems to the Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: \_\_\_\_\_

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: \_\_\_\_\_

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

\_\_\_\_\_ signature

\_\_\_\_\_ date

Owner's Representative:

\_\_\_\_\_ signature

\_\_\_\_\_ date

### **3.3 DELIVERY AND STORAGE**

- A. Deliver and store products per Division 1 requirements.
- B. Store in dry and clean space(s). Leave products in factory shipping materials and/or protect from water, dust and other debris.
- C. Provide environmental heating as necessary to prevent moisture damage.

### **3.4 EQUIPMENT ACCESS**

- A. Maintain equipment clearances and access, repair or removal for maintenance. Relocate equipment, devices, raceways, etc. to allow maintenance access at no additional cost to the Owner.
- B. Refer to Architectural elevations for device locations. Identify locations that may have limited access prior to installation of equipment or devices.
- C. Verify location of door latch prior to installation of light switches.

### **3.5 SUPPORTS**

- A. Provide supporting steel as necessary for installation of equipment including hangers, support frames, beams, etc.
- B. Use steel plug type concrete anchors of equipment supports. Lead, plastic or other materials are not permitted.
- C. Do not support equipment or luminaires from metal roof decking.
- D. Protect threaded rods, bolts and any other sharp edges mounted below 7'-0" above finished floor to protect personnel from injury.

### **3.6 CLEANING**

- A. Prior to assembly of electrical equipment, all loose dirt, scale, oil and other foreign matter on internal and exterior surfaces shall be removed by means consistent with good electrical practices.
- B. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. Name plates, ratings, instruction plates, etc., shall not be obscured by paint, insulation, or placement of units.
- C. Electrical equipment shall be thoroughly cleaned on the interior and exterior of equipment. This includes but is not limited to removal of wiring trimmings within electrical panels and dirt/debris from activation boxes.
- D. All light fixtures shall be wiped clean with all fingerprints and dust removed.

**END OF SECTION 26 05 00**

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## **SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

### **PART 1 - GENERAL**

#### **1.1 RELATED WORK**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 - Common Work Results for Electrical are applicable to work required of this section.

#### **1.2 DESCRIPTION OF WORK**

- A. Contractor shall furnish all material, tools, labor, and supervision necessary to install all wiring systems.
- B. This section describes the basic materials and methods of installation for general wiring systems of 600 volts and less. Wiring for a higher voltage rating, if required, shall be as specified in other sections or called for on the drawings.

#### **1.3 QUALITY ASSURANCE**

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable, and connectors.
- B. UL Compliance: Comply with UL standards pertaining to wire, cable, and connectors.
- C. UL Labels: Provide electrical wires, cables and connectors which have been UL listed and labeled.
- D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of wire and cable.
- E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.
- F. The materials used for wiring systems shall be the products of a manufacturer regularly engaged in the manufacturing of the specified material.

#### **1.4 SUBMITTALS**

- A. Product Data: Submit manufacturer's technical product data for each product specified.

### **PART 2 - PRODUCTS**

#### **2.1 WIRE AND CABLE**

- A. All wire and cable for power, lighting, control, and signal circuits shall have copper conductors of not less than 98% conductivity and shall be insulated to 600 V. Conductor sizes #12 AWG and smaller shall be solid, conductor sizes #10 AWG and larger shall be stranded.
- B. Minimum size conductors shall be #12 AWG for power and lighting.

- C. Type of wire and cable for various applications shall be as follows:
1. Type THHN/THWN-2, or XHHW-2 (90 deg. C) use for branch circuits, Class 1 Control circuits, panel and equipment feeders in dry locations. Use XHHW-2 between VFD and motor.
  2. Type XHHW-2 (90 deg. C) use for branch circuits, panel and equipment feeders located underground and in wet and dry locations.
  3. Type XLPE (105 deg. C) twisted conductors – use for Class 2 and 3 circuits.
  4. 2-Hour Fire Rated Cable System. UL 2196 listed for horizontal and vertical installations.
    - a. Pentair System 1850 Type MI mineral insulated cable.
    - b. Omni Cable VITALink Type MC 2-hour rated power cable.
    - c. Draka Lifeline MC 2-hour rated power cable.
    - d. RHW-2 based cable systems are not acceptable.
    - e. Provide all proprietary terminations and components for a complete listed system.
  5. Type UF use where permitted by other sections or by the drawings for underground burial branch circuits.
  6. Type SO – use for cord drops and portable appliance connections. Use wire mesh, stainless-steel strain relief at terminations.
  7. **Type MC – Metal-clad Cable – use for branch circuit from homerun junction box to in-wall device and recessed light fixtures.**
  8. For all vibration type installations (i.e. motors, etc.), provide stranded type conductors.

## 2.2 CONDUCTOR COLOR CODING

- A. Wiring systems shall be color coded. Conductor insulation shall be colored in sizes up through #8 AWG. Conductors #6 AWG and larger shall be colored or have black insulation and shall be phase color coded with one half inch band of colored tape at all junctions and terminations. Colors shall be assigned to each conductor as described below and carried throughout all main and branch circuit distribution. When necessary to use tape, use colored tape on black wire. Do not use colored tape on colored wire.

	120/240V - Delta	120/208V - Wye	277/480V - Wye
Phase 'A' Conductor	Black	Black	Brown
Phase 'B' Conductor	Orange**	Red	Orange
Phase 'C' Conductor	Red	Blue	Yellow
Neutral Conductor	White*	White*	Grey*
Equipment Grounding Conductor	Green	Green	Green
Isolated Grounding Conductor		Green w/Yellow Stripe	Green w/Yellow Stripe

\* For branch circuits with non-shared neutral conductors, provide colored tracer to match associated phase conductor. Tracers shall be Black, Red, Blue, Brown, Orange, or Yellow.

\*\* Use red and black for phases which are 120V to neutral. Use orange for "wild leg".

## 2.3 CONNECTORS

- A. Twist-on Wire Connectors.
1. Dry Locations. 600V rated, UL 486C listed, Ideal Industries 451/452/454 or equal by 3M or Thomas and Betts. Use for #8 and smaller.

2. Wet locations. 600V rated, UL 485D listed with pre-filled silicone sealant. Ideal industries 61/62/63 series or equal by 3M or Thomas and Betts. Use for #8 and smaller. To be used for all above ground splices in exterior locations and interior wet locations.
  3. Underground locations. 600V rated, UL 485D listed for direct burial with pre-filled silicone sealant. Ideal Industries 60/64/66 series or equal buy 3M or Thomas and Betts. Use for #8 and smaller. To be used for all below ground and in-slab locations.
- B. Push-in Wire Connectors.
1. Dry Locations. 600V rated, UL 486C listed, Ideal Industries 32/33/34 or equal by Wago, 3M or Thomas and Betts. Use for #10 and smaller.
- C. Conductor Taps and Splices.
1. Dry Locations. 600V rated, UL 486A/B listed, insulated mechanical termination. IlSCO ClearTap PCT or equal by Burndy. Use for #6 and larger.
  2. Wet and Underground Locations. 600V rated, UL 486D listed, watertight mechanical termination suitable for direct burial in earth. IlSCO SafetySub PDSS or equal by Burndy or 3M. Use for #6 and larger.
  3. Insulation piercing taps are not allowed.
  4. Split bolt connectors and splices are not allowed.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Wire shall not be installed in the conduit system until the building is enclosed and masonry work is completed.
- B. Conduit shall be swabbed free of moisture and debris prior to pulling in wiring. Pull mouse through conduits prior to pulling conductors.

#### **3.2 INSTALLATION**

- A. All cable for major feeders shall be continuous from origin to termination, unless otherwise indicated.
- B. Branch circuit conductor sizes shall be increased to maintain a maximum 3% voltage drop.
  1. 120V, 20A homeruns shall be sized as follows based on one-way circuit length:
    - a. 0-80': #12 AWG
    - b. 81'-140': #10 AWG
    - c. 141'- 210': #8 AWG
    - d. 211' and over: #6 AWG
  2. 277V, 20A homeruns shall be sized as follows based on the one-way circuit length:
    - a. 0-200': #12 AWG
    - b. 201'-300': #10 AWG
    - c. 301' and over: #8 AWG
- C. Conductors for emergency power systems shall be kept in entirely independent of all other wiring and equipment. Emergency system wiring shall not occupy the same raceway, wireway or junction box.

- D. Conductors for critical branch, life safety branch, equipment branch and normal shall be kept entirely independent of one another and all other wiring and equipment. Wiring for these systems shall not occupy the same raceway, wireway or junction box,
- E. Conductors for 208V and 480V systems shall be installed in separate raceway systems.
- F. Splices shall be made only in accessible junction boxes or handholes.
- G. All power feeder cable shall be pulled with the use of approved pulling compound or powder. Compound must not deteriorate conductor or insulation.
- H. If conductor insulation is damaged during installation, replace entire conductor.
- I. Use pulling means, including fish tape, cable or rope which cannot damage raceway.
- J. Install exposed cable, parallel and perpendicular to surfaces or exposed structural members and follow surface contours, where possible.
- K. Keep branch circuit conductor splices to a minimum.
- L. The continuity of circuit conductors shall not be dependent on service connections such as lamp holders, receptacles, etc., where the removal of such devices would interrupt the continuity.
- M. Provide separate green equipment ground conductor throughout entire electrical system.
- N. Isolated ground conductors shall be kept isolated from the equipment grounding system from the outlet back to where the system is derived.
- O. All branch circuits shall have dedicated neutrals.
- P. Install 2-hour rated cable systems in strict accordance with the manufacturer's instructions and the UL Listing.
- Q. Leave at least 6" of slack for terminations at wiring devices.
- R. For all vibration type installations (i.e. motors, etc.), provide stranded type conductors.
- S. Support cables above accessible ceilings from structure. Do not place cables on ceiling panels.

### **3.3 FIELD QUALITY CONTROL**

- A. Prior to energizing system, test cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.
- B. After wire terminations are complete, energize circuitry and demonstrate function in accordance with requirements.

**END OF SECTION 26 05 19**

## SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 - Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of grounding work is indicated by drawings and shall comply with NEC.
- B. Applications of grounding work in this section include the following:
  - 1. Underground metal piping.
  - 2. Underground metal water piping.
  - 3. Underground metal structures.
  - 4. Metal building frames.
  - 5. Grounding electrodes.
  - 6. Grounding rods.
  - 7. Separately derived systems.
  - 8. Service equipment.
  - 9. Enclosures.
  - 10. Equipment.
- C. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL-listed and labeled.
- B. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical grounding and bonding.
- C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.

### PART 2 - PRODUCTS

#### 2.1 GROUNDING SYSTEMS

- A. Materials and Components
  - 1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

2. All components shall be listed under ANSI/UL 467 – “Grounding and bonding Equipment”.
  3. Raceways: Provide raceways, and electrical boxes and fittings complying with Division 26, Section 26 05 33 – Raceway and Boxes for Electrical Systems.
  4. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC.
- B. Connectors
1. Lugs: Grounding and bonding conductors shall terminate in two-hole, long barrel irreversible compression lugs, Burndy YGA series or equal by Blackburn, IlSCO, Erico, Harger, or Anderson.
  2. Exothermic welds: Graphite mold designed for the specific connection type required. Weld metal used for grounding connections shall contain copper oxide, aluminum and not less than 3% tin as the wetting agent. Exothermic weld products by Erico, Harger or approved equal.
  3. Ground clamps for pipes: Bronze with pad for 2-hole lug, Burndy GAR-TC series or equal by Blackburn, IlSCO, Erico, Harger, or Anderson.
- C. Ground bars: Ground bars shall be 4” wide, ¼” thick solid copper with insulating bushings and 7/16” holes. Hole spacing to accommodate ¾”, 1” and 1-3/4” lugs. Ground bars shall be a minimum of 12” long, refer to plans for specific length.
1. Ground bars for telecommunications shall be manufactured to TIA-607-B.
- D. Grounding Rods
1. Ground Rods:
    - a. Copper clad steel, 3/4" dia. x 10' for service entrance.
    - b. Copper clad steel, 5/8” dia x 8’ for other applications.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF ELECTRICAL GROUNDING**

- A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.
- C. Install bonding jumpers with ground clamps on water meter piping to electrically bypass water meters.
- D. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- E. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

- F. Bury ground rods vertically with rod top a minimum of 2 feet below grade, or with rod top terminated in a gravel filled ground well. If extensive rock formation is encountered, inform the Design Professional and relocate ground rods, or provide supplemental ground rods as directed by the Design Professional.
- G. A No. 6 AWG minimum stranded copper wire shall be furnished and exothermically welded to all of the ground rods.
- H. Protect ground conductors from physical and environmental damage. Wherever possible, and where indicated, grounding electrode and bonding conductors shall be enclosed in a non-metallic raceway. Where ground conductors are subject to physical damage, install in galvanized rigid steel conduit with grounding bushings on each end. Locate exposed conductors which must extend from a concrete surface as close as possible to a corner. Where conductors are required to be exposed, as in the connection to the main ground bus, support ground conductors by corrosion resistant metallic hardware at 4-foot intervals or less.
- I. Exothermic Welding
  - 1. Clean and dry the surface to be welded. Wire brush or file the point of contact to a clean bare metal surface.
  - 2. Use welding cartridges and molds for the type of weld recommended by the manufacturer and perform welding in accordance with the manufacturer's recommendations. Worn or damaged molds not to be used.
  - 3. Test all welds by striking with a 2 pound steel hammer. Replace any defective welds.
  - 4. Where exothermic welds are made to a galvanized surface, remove the galvanizing using a grinding wheel to expose a clean surface. After welding, touch up the steel surface with zinc rich primer.
- J. Provide separate green ground conductor throughout entire electrical system sized as required by the NEC.
- K. Conduit Grounding
  - 1. Bond all metallic conduit systems together to provide a continuous electrical ground path. Bond metallic conduits to other conduit components using insulated ground bushings when required. Connect ground bushings to the grounding system using conductors sized in compliance with NEC.
  - 2. Provide ground conductors in non-metallic conduits in accordance with the NEC.
- L. All portions of the metal building structure that are not electrically continuous shall be bonded to the service entrance grounding electrode system.
- M. Bond natural gas piping to the grounding system in accordance with the NEC and International Fuel Gas Code with a #6 AWG conductor to the main ground bar.

**3.2 FIELD QUALITY CONTROL**

- A. Upon completion of installation of electrical grounding system, test ground resistance with earth test megger. Results shall be submitted to the Design Professional on a report form similar to that which follows:

**EARTH RESISTANCE  
FIELD REPORT**

PROJECT: \_\_\_\_\_

JOB NUMBER: \_\_\_\_\_ PAGE \_\_\_\_\_

OWNER: \_\_\_\_\_

DATE OF TEST: \_\_\_\_\_ CONDITIONS: \_\_\_\_\_

TEST LOCATION: \_\_\_\_\_

TEST METHODS: \_\_\_\_\_

TEST INSTRUMENT: \_\_\_\_\_

SOIL RESISTIVITY/TYPE: \_\_\_\_\_

COMMENTS (If applicable): \_\_\_\_\_

**TESTING RESULTS:**

Earth Resistance Testing: Resistance \_\_\_\_\_ to earth  
Description of systems tested \_\_\_\_\_

Test No.

A)

B)

C)

D)

E)

COMPLETED BY: \_\_\_\_\_ COPY TO: \_\_\_\_\_

COMPANY: \_\_\_\_\_



- B. Where tests show resistance to ground is over 3 ohms, take appropriate action to reduce resistance to 3 ohms or less by driving additional ground rods or by chemically treating soil encircling ground rod.
1. Retest to demonstrate compliance.

**END OF SECTION 26 05 26**

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## SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide materials, labor and supervision as necessary to provide hangers and supports for conduit, fixtures and equipment.

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical supporting devices.
- B. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA Std. Pub. No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies".
- C. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
- D. UL Compliance: Provide electrical components which are UL listed and labeled.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURED SUPPORTING DEVICES

- A. Manufacturer: Subject to compliance with requirements, provide channel systems of one of the following:
  - 1. B Line Systems, Inc.
  - 2. Thomas & Betts, Superstrut
  - 3. Unistrut Div.; Tyco International
  - 4. Globestrut
- B. General: Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. Where more than one type of device meets indicated requirements, selection is Installer's option.
- C. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for rigid metal conduit; type wire as indicated; construct body of malleable iron casting with hot dip galvanized finish.
- D. U Channel Strut Systems: Provide U channel strut system for supporting electrical equipment, 16-gauge hot dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U channel:
  - 1. Fixture hangers.

2. Channel hangers.
3. End caps.
4. Beam clamps.
5. Wiring stud.
6. Thinwall conduit clamps.
7. Rigid conduit clamps.
8. Conduit hangers.
9. U bolts

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF SUPPORTING DEVICES**

- A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements.
- B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- C. Conduit hangers and support devices shall be approved type for the method of supporting required. Size supports as necessary per manufacturer's recommendations for the weight being supported. All hangers and supports shall have galvanized finish or other approved corrosion resistance finish. In general, hangers and supports shall be as follows:
  1. Where single or multiple run of conduit is routed on surface of structure; use conduit clamps mounted on U channel strut so as to maintain not less than 1" clearance between conduit and structure.
  2. Where single run of conduit is suspended from overhead; use split ring conduit clamp suspended by 3/8" steel drop rod.
  3. Where multiple parallel runs of conduit are suspended from overhead; use split ring conduit clamps uniformly spaced and supported on trapeze hangers fabricated of U channel strut, suspended by not less than two steel drop rods.
  4. Where circuit voltage is above 600 volts, conduit clamps shall be provided with insulating bushings of dielectric strength as required.
  5. Where conduit is buried in concrete floor topping; anchor conduit to structural floor with one-hole jiffy clamps.
  6. Maximum hanger and support spacing shall be in accordance with NEC.
- D. Hangers and supports shall be anchored to structure as follows:
  1. Hangers and supports anchored to poured concrete, use malleable iron or steel concrete inserts attached to concrete forms.
  2. Hangers or supports anchored to precast concrete, use self-drilling expansion shields. Expansion shields may be used where concrete inserts have been missed or additional support is required in poured concrete.
  3. Hanger or supports anchored to structural steel, use beam clamps and/or steel channels as required by structural system.
  4. Hangers or supports anchored to metal deck, use spring clips or approved welding pins. Maximum permissible load on each hanger shall not exceed 50 pounds.
  5. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls.
  6. Use sheet metal screws in sheet metal studs and wood screws in wood construction.

- E. The following is not permitted:
1. Attaching supports and hangers to piping, ductwork, mechanical equipment, or conduit.
  2. Use of powder-actuated anchors.
  3. Drilling of structural steel members.
- F. Fixtures on plastered or acoustical ceilings shall not be supported directly on ceiling tile. Provide metal bar hangers or U channel strut attached to ceiling supports.
- G. Where disconnect switches and panels cannot be mounted on wall, provide support racks fabricated of structural steel or U channel strut.
- H. Where disconnects or equipment is designated as NEMA 4X, provide stainless steel support and hardware.
- I. Provide concrete bases and pads for transformers, switchgear, free standing panels, generators, outdoor lighting poles and other equipment requiring bases, except where drawings indicate that such bases and pads are to be furnished by the General Contractor. Pads shall be 3.5" tall and extend 4" beyond footprint of equipment. Furnish all equipment anchor bolts and installation for their proper and accurate location. All concrete work and reinforcing shall comply with General Specifications.

**END OF SECTION 26 05 29**

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## SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 0500 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all materials, tools labor and supervision necessary to fabricate and install complete conduit systems.
- B. Conduit systems shall be provided for all wiring, except where the drawings or other sections of the specifications indicate that certain wiring may be installed in cable trays, surface raceway, underfloor raceway, wireways and/or auxiliary gutters.
- C. Types of raceways in this section include the following:
  - 1. Rigid metal conduit.
  - 2. Intermediate metal conduit.
  - 3. Electrical metallic tubing.
  - 4. Flexible metal conduit.
  - 5. Liquid tight flexible metal conduit.
  - 6. Rigid nonmetallic conduit.
  - 7. MC cable.
  - 8. Surface metal raceways.
- D. Provide factory painted red conduit for fire alarm system.
- E. Contractor shall furnish all material, tools, labor and supervision necessary to install electrical boxes and fittings as required by drawings and specifications.
- F. Types of electrical boxes and fittings in this section include the following:
  - 1. Outlet boxes.
  - 2. Junction boxes.
  - 3. Pull boxes.
  - 4. Wireways
  - 5. Activation boxes.
- G. Telecommunications Raceway Requirements:
  - 1. The term “telecommunications” includes all low voltage technology systems including voice and data, access control, video surveillance, intrusion detection, audio video, induction loop, paging, intercom, nurse call, school bell and/or clock systems. The term does not include fire alarm system, which is addressed separately in the plans and specifications.
  - 2. Contractor shall provide and install telecommunications boxes and conduits, including wall sleeves unless otherwise noted.
  - 3. See section 26 0553 for raceway identification requirements including colored conduit.

4. All optical fiber shall be run in 2" orange EMT conduit. Division 27 13 23 Contractor shall coordinate with Div 26 Contractor in the routing of raceways.
5. Interior building, above grade conduits and sleeves shall be EMT unless otherwise noted. PVC is never acceptable above grade.
6. All interior conduits shall have bushings installed during conduit installation. Completed individual installations shall have bushings installed same business day.
7. All interior conduits shall have pull strings, except sleeves which are less than 4' long. EMT conduits shall receive standard round cable pull string (multi-strand plastic twine type).
8. Minimum interior conduit size for all information jacks (voice data cabling) shall be 1" unless otherwise noted.
9. Minimum interior conduit size for audiovisual shall be 1" unless otherwise noted. Junction (pull) boxes shall be added at a maximum of 100' of raceway distance, and also for a maximum of 180 degrees of bend radius.
10. Minimum interior conduit size for video surveillance, intrusion detection, paging, intercom, nurse call, school bells and/or clock systems shall be 3/4" unless otherwise noted.
11. Access control system conduit sizes at the door location shall be per the access control detail found on the drawings. The conduit from the door location to the access control head end which contains all conductors needed for all access control functions at that door (may be individual conductors but is often one large composite cable) shall be minimum 3/4".
12. Boxes for all low voltage systems in stud walls shall be metallic 5"x5"x2.875" with single gang mud ring unless otherwise noted.
13. Boxes in masonry walls shall be minimum 3.5" deep. single gang, unless otherwise noted.
14. Wiremold surface raceway for all low voltage systems shall be minimum V2400 unless noted otherwise.
15. Wiremold surface boxes for all low voltage shall be minimum 2.5" deep single gang, unless otherwise noted.
16. Conduits inside walls which feed the low voltage side of dual compartment Wiremold shall be minimum 1.25"

### **1.3 QUALITY ASSURANCE**

- A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL listed and labeled.
- C. NEC Compliance: Comply with requirements as applicable to construction and installation of raceway systems.
- D. The materials used in the fabrication of the raceway system shall be products of a manufacturer regularly engaged in the manufacturing of the specified material.
- E. NEC compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- F. UL Compliance: Provide electrical boxes and fittings which have been UL listed and labeled.
- G. ANSI/NEMA Standards Compliance: Comply with ANSI C 134.1 (NEMA Standards Pub No. OS 1) as applicable to sheet steel outlet boxes, covers and box supports.



## 1.4 SUBMITTALS

- A. Raceway Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway listed below. Include data substantiating that materials comply with requirements for the following:
  - 1. Raceway
  - 2. Surface Metal Raceway
- B. Activation Box Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each type of activation box required. Include data substantiating that units comply with requirements.
- C. In-Ground Handhole Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each type of handhole required. Include data substantiating that units comply with requirements.

## PART 2 - PRODUCTS

### 2.1 RACEWAYS

- A. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums. Surface raceway shall be used where exposed in finished regularly occupied areas. See 26 0553 for color conduit requirements.
- B. Rigid Conduit: Full weight, threaded, rigid steel conduit, galvanized inside and out by hot dip or electro galvanized process. Additional protection by electrostatically applied baked coating. Thread protective caps and couplings. Use for all feeders larger than 2 1/2" in size.
- C. Intermediate Metal Conduit (IMC): May be used as approved by code where rigid conduit is specified, except shall not be used for conduit buried in earth fill.
- D. Electrical Metallic Tubing: Thin wall, electrically welded cold rolled steel conduit, galvanized inside and out by electro galvanized process. Baked clear elastic enamel coating in and out. Use for installations in stud walls, masonry walls, above suspended ceilings and where exposed. Size limited to 2 1/2" and smaller.
- E. Flexible Metal Conduit: Formed of one continuous length of spirally wound electro galvanized steel strip. Use for final connections to all motor operated equipment such as unit heaters, fans, air handling units, pumps, generators, generator enclosures and connections to dry type transformer, connections from junction boxes to lighting fixtures in accessible ceiling, and for wiring within casework and millwork. 6' maximum length.
- F. Liquidtight Flexible Metal Conduit: Formed of one continuous length of spirally wound steel strip, with water and oil tight neoprene jacket. Use for final connection to equipment listed in paragraph "E" above when located in wet areas.
- G. PVC Conduit: Conduit shall be Carlon PV Duit, Type 40, 90 deg.C. Conduit shall be composed of Polyvinyl Chloride and shall conform to NEMA Standards. Conduit, fittings and cement shall be produced by the same manufacturer. May be used where installed in earth fill or in poured concrete walls, columns, floors, or under concrete slab.

- H. Rigid Aluminum Conduit: Full weight, threaded, rigid aluminum conduit. Thread protective caps and couplings.
- I. MC cable will not be allowed.
- J. Surface Metal Raceways: Provide surface metal raceways of sizes and channels indicated on plans (or as otherwise defined below) and constructed of steel or aluminum with covers. Finish with manufacturer's standard baked on enamel paint or exposed metal as scheduled on drawings. Use where exposed in finished regularly occupied areas.
  - 1. Manufacturer: Subject to compliance with requirements, the following manufacturers are acceptable:
    - a. Wiremold (basis of design) – G4000 with compatible devices and covers for Court Reporter stations. V700 for single service mounted devices (power, data) in public spaces. V3000 with compatible covers for routing services to surface mounted device boxes.
    - b. Hubbell

## 2.2 CONDUIT FITTINGS

- A. Rigid Conduit Fittings:
  - 1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper. Aluminum fittings shall be used with aluminum conduit only.
  - 2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
  - 3. Bushings shall be of the metallic insulating type and consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
  - 4. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type.
  - 5. Set screw fittings are not allowed.
- B. Metallic Tubing Fittings: Compression type galvanized or zinc coated malleable iron or steel, water and concrete tight where exposed to wet locations or imbedded in concrete. Steel set screw type acceptable in all dry location applications. Die-cast fittings are not allowed.
- C. Flexible Metal Conduit Fittings: External squeeze or set screw type galvanized or zinc coated malleable iron or steel with nylon insulated throats. Internal screw type fittings are not allowed.
- D. Liquidtight Flexible Conduit Fittings: Galvanized malleable iron or steel, with watertight gaskets, "O" ring and retainer, and nylon insulated throats.
- E. Condulet Fittings: Exposed conduit fittings shall be condulet type for all sharp turns, tees, etc.
- F. Surface Metal Raceway Fittings: Provide types that match and mate to raceways provided.
- G. Provide insulated bushings for all conduits terminations.

## 2.3 WALL OUTLET BOXES

- A. General: Boxes shall be Raco, Steel City, Appleton or equal, catalog numbers based on Raco, unless otherwise indicated. In general, the type of boxes shall be as follows:
1. In Stud Walls: For single outlet use 4" square by 2-1/8" deep box. Boxes to be provided with raised covers of depth as required for thickness of wall materials.
  2. In Masonry and Poured Concrete Walls: Use 3 3/4" high by 2 1/2" and/or 3 1/2" deep masonry boxes #691 through #694 and/or #695 through #699.
  3. Surface Mounted Wall Outlets for conduit: Use 4" square by 1 1/2" deep box #192 with raised cover.
  4. Surface Mounted Wall Outlets for surface metal raceway: Use single gang boxes 1-1/2" deep Wiremold #V57xx series.
  5. Suspended Ceiling: Use octagon boxes, depth as required for application, securely fastened to structure.
  6. Poured Concrete Ceiling Slabs: Use octagon concrete rings with back plates.
  7. Outlets Installed Outdoors or in Wet Locations: Use Bell Product 53XX Series outlet box.

## 2.4 ACTIVATION BOXES

- A. Activation Boxes: Provide boxes as scheduled on the drawings.
- B. Activation boxes shall be provided with barriers to separate high and low potential voltages.
- C. Activation boxes shall be, complete with necessary gaskets, plates, spacers, mud caps, covers, fasteners, brackets and ancillary components appropriate for their installation. Follow manufacturer's specific written instructions for each type of installation.
- D. Furnish electrical outlets with duplex receptacles per specification Section 26 2726 – Wiring Devices.
- E. Manufacturers: Subject to compliance with requirements, the following manufacturers are acceptable:
1. Wiremold/Legrand/Chief
  2. FSR Inc.
  3. Hubbell
  4. Steel City

## 2.5 PULL BOXES, AND JUNCTION BOXES

- A. Construction, sizes and installation of pull boxes and junction boxes shall comply with NEC, Article 314.
- B. Pull and junction boxes not specifically described in NEC, Article 314, shall be fabricated of heavy gauge galvanized steel with screw or hinged covers, and equipped with corrosion resistant screws and hardware.
- C. Pull and junction boxes for installation in poured concrete floors shall be flush type, cast iron, with watertight gasketed covers. Boxes for installation in floors with tile or carpet floor covering shall have recessed covers to accommodate the floor covering.
- D. Pull boxes and junction boxes for outdoor installation shall be raintight.

- E. Pull boxes, and junction boxes designated '4X' shall be NEMA 4X water tight and corrosion resistant.

## **2.6 METAL WIREWAYS**

- A. Construction, sizes and installation metal wireways shall comply with NEC, Article 376.
- B. General: Provide electrical raceways of types, grades, sizes and weights (wall thicknesses), number of channels, for each type of gutter indicated. Provide complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for complete system. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements, and comply with applicable provisions of NEC for electrical raceways.
- C. Wireways shall be constructed as a complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for complete system. Gutters shall have hinged covers. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements.
- D. Wireways shall have hinged covers unless noted otherwise.
- E. Wireways for outdoor installation shall be raintight.
- F. Wireways designated '4X' shall be NEMA 4X watertight and corrosion resistant.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF RACEWAY**

- A. In general, all horizontal runs of branch circuit conduit shall be installed in ceiling plenum. Raceway for convenience outlets, wall mounted fixtures and other wall outlets shall be routed overhead and dropped through wall to the outlet.
- B. Branch circuit raceway shall not be installed in or below concrete floor slabs except where conditions will not permit the raceway to be installed overhead. Conduit shall be used where concealed in permanent wall construction or in ceiling plenums.
- C. Surface raceway shall be used where exposed in finished regularly occupied areas where walls are existing.
- D. Feeder conduits to panelboards and other major loads may be installed in fill below concrete slabs on grade.
- E. Conduits that are run in fill below concrete slabs on grade shall be installed so as not to interfere with welded wire mesh (wwm), vapor barrier, or concrete placement.
- F. Generally, all conduit shall be concealed, except in crawl spaces, tunnels, shafts, mechanical equipment rooms, and at connection to surface panels and free standing equipment, and as otherwise noted.
- G. Exposed conduit and conduit concealed in ceiling space shall be routed in lines parallel to building construction.

- H. All conduit runs above suspended acoustical ceilings shall be routed so as not to interfere with tile panel removals with 4'0" to 6'0" flexible conduit drops from an independent junction box, accessible from below the ceiling, to ceiling mounted equipment.
- I. Minimum size conduit shall be 3/4" trade size. Minimum size surface raceway shall be V700. Where specified size is not called for on drawings or in the specifications, conduit shall be sized per NEC.
- J. Utilize approved thread lubricant for rigid steel and aluminum conduits to ensure equipment grounding paths.
- K. Utilize approved thread sealant for all underground and wet locations threaded conduit joints.
- L. Install the conduit system mechanically and electrically continuous from outlet to outlet and to all cabinets, junction or pull boxes. Conduit shall enter and be secured to all cabinets and boxes in such a manner that all parts of the system will have electrical continuity.
- M. All conduit penetrations to the exterior of the building including the service entrance, telecommunications, site feeds, grounding electrode and spare conduits shall be sealed at one or both ends against the intrusion of water and gasses. The seal shall be identified for use with the cable insulation installed. All seals shall be removable.
- N. Installation of PVC conduit shall comply with the NEC with regard to grounding and expansion fittings.
- O. PVC conduit shall not be installed above grade unless noted otherwise.
- P. Support conduit raceway systems in accordance with requirements as set forth in the National Electric Code.
- Q. All connections to NEMA 3R enclosures shall maintain the enclosure listing regardless of the equipment location.
- R. Provide liquidtight flexible metal conduit for the last 3' of feeder/circuit for all vibration type equipment (i.e. motors, transformers, etc).

### **3.2 INSTALLATION OF BOXES AND FITTINGS**

- A. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.

### **3.3 OUTLET BOX INSTALLATION**

- A. Outlet boxes shall be installed for all fixtures, switches, receptacles and other devices.
- B. Approximate locations of outlets are shown on the plans, but each outlet location as shown shall be checked by Contractor before installing the outlet box.

- C. Wall boxes installed flush in common wall shall not be back to back or through wall type. Boxes located on opposite sides of a common wall that are closely connected by conduit shall have the conduit openings plugged with duct seal.
- D. Install boxes and conduit bodies in those locations to ensure ready accessibility of electrical wiring.
- E. Outlet boxes shall be installed plumb and square with wall face and with front of box or cover located within 1/8" of face of finish wall. Boxes in masonry shall be set with bottom or top of the box tight to the masonry unit.

#### **3.4 PULL BOX, JUNCTION BOX & WIREWAY INSTALLATION**

- A. Install pull boxes, junction boxes and auxiliary wiring gutters where indicated on drawings and where required to facilitate installation of the wiring.
- B. For concealed conduit, install boxes flush with ceiling or wall, with covers accessible and easily removable. Where flush boxes are installed in finish ceilings or walls, provide cover which shall exceed the box face dimensions by a sufficient amount to allow no gap between box and finished material.
- C. Boxes shall not be located in finished, occupied rooms, without prior approval of Design Professional.

#### **3.5 ACTIVATION BOX INSTALLATION**

- A. Install activation boxes flush with surrounding wall or floor surface, factor in lids and covers in addition to wall/floor finishes when setting boxes.
- B. Coordinate raceway into boxes with Telecom and AV Contractors to limit number of bends and entry into appropriate sides of boxes.
- C. Coordinate exact placement of boxes with Architectural details, do not scale drawings for locations.

**END OF SECTION 26 05 33**

## SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall provide identification for wiring systems and equipment as called for in this section.
- B. Types of electrical identification specified in this section include the following:
  - 1. Conduit color banding.
  - 2. Buried cable warnings.
  - 3. Cable conductor identification.
  - 4. Operational instructions and warnings.
  - 5. Danger signs.
  - 6. Equipment/system identification signs.

#### 1.3 QUALITY ASSURANCE

- A. UL Compliance: Comply with applicable portions of UL safety standards pertaining to electrical marking and labeling identification systems.
- B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

### PART 2 - PRODUCTS

#### 2.1 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.
- B. Color Coded Conduit System
  - 1. General: Provide manufacturer's standard colored conduit for EMT installations as noted below. For rigid aluminum, rigid steel, and IMC conduit, use colored electrical tape to band conduits within 6" of termination at each switchboard, panelboard, distribution board, pull box and junction box. Where conduit is exposed and painted to match adjacent surfaces, band with colored electrical tape.

2. Colors:
  - a. Normal Power: gray/silver (uncolored)
  - b. Emergency: yellow\*
  - c. Fire alarm: red\*
  - d. Division 27 fiber: orange\*
  - e. Division 27 all other systems: purple\*\*
  - f. Division 28 systems excluding fire alarm: purple\*\*

\* Factory colored conduit required for EMT conduit  
 \*\* Field applied electrical tape banding at conduit terminations required. Factory colored conduit optional for EMT conduit.

3. For exposed conduits in finished spaces, refer to architectural for paint to match room finish.
4. For branch circuits, mark panel name and circuit numbers on all junction/pull boxes.

C. Underground Type Plastic Line Marker

1. General: Manufacturer's standard permanent, bright colored, continuous printed plastic tape; not less than 6" wide x 4 mils thick intended for underground service. Provide tape with printing which most accurately indicates type of service of buried cable/conduit.

D. Cable/Conductor Identification Bands

1. General: Provide manufacturer's standard vinyl cloth self-adhesive cable/conductor markers of wrap around type; either pre numbered plastic-coated type or write on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

E. Self-Adhesive Tape for Receptacle Circuit Identification

1. General: Provide clear self-adhesive or pressure sensitive, preprinted, flexible vinyl tape for panel name and circuit number.

F. Engraved Plastic Laminate Signs

1. General: Provide engraving stock melamine plastic laminate, in sizes and thickness indicated, engraved with engraver's standard letter style of sizes and wording indicated, black and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
  - a. Thickness: 1/16", for units up to 20 sq. in. or 8" lengths; 1/8" for larger units.
  - b. Fasteners: Self tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate substrate.

**PART 3 - EXECUTION**

**3.1 APPLICATION AND INSTALLATION**

A. General Installation Requirements

1. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.



B. Conduit Identification

1. Conduit above accessible ceiling spaces shall be identified per 2.01 B.
2. Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by a color coded method, apply color coded identification on electrical conduit in a manner similar to piping identification.
3. Identify junction and pullboxes of systems with stencil lettering for panel and circuit numbers or system type.

C. Underground Cable/Conduit Identification

1. General: During back filling/top/soiling of each exterior underground electrical, signal or communication cable or conduit, install continuous underground type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.

D. Cable/Conductor Identification

1. General: Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents and similar previously established identification for project electrical work.

E. Operational Identification and Warnings

1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

F. Equipment/System Identification

1. General: Install engraved plastic laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system, unless unit is specified with its own self-explanatory identification. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1 1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work.
  - a. Panelboards, electrical cabinets and enclosures.
  - b. Access panel/doors to electrical facilities.
  - c. Major electrical switchgear.
  - d. Motor control centers, disconnects & starters.
  - e. Power transfer equipment.
  - f. Transformers.
  - g. Inverters.
  - h. Generators.

2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.
3. Provide labeling of Enclosed Circuit Breakers, Switchboards, Panelboards and Disconnects per NEC Articles 110, 700 and 702 for multiple services and essential electrical system.
4. All receptacles and light fixtures shall be labeled with panel and circuit number. Final location of label shall be field coordinated. If labeling is to be on outside of cover, Contractor shall use clear dyno-tape with black lettering that matches other tags.
5. All panelboards shall be labeled with panel ID, conduit size, feeder wire size, origin and size of overcurrent protection device serving panelboard and phase schedule. Format shall be as follows:  
"Panel XX, 1.25"C, 4#3, 1#8, Fed from Dist. Bd. XX by 100A/3P  
Phase A: Black, Phase B: Red, Phase C: Blue"
6. All new switchboards and panelboards shall be labeled (5/32" or larger) with the following:  
"Caution – This equipment has a minimum short circuit design requirement of \_\_\_ KA. All devices installed must have a rating equal or higher than the design requirement."
7. All safety switches shall have a permanent label attached to inside of cover describing the fuse size, type, current limiting ability and devices controlled.

**END OF SECTION 26 05 53**

**SECTION 26 05 73 - SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD  
ANALYSIS**

**PART 1 - PART 1 - GENERAL**

**1.1 SCOPE**

- A. The contractor shall furnish short-circuit, protective device coordination studies and arc flash analysis which shall be prepared by the equipment manufacturer or third party Engineering Services Organization.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

**1.2 RELATED SECTIONS**

- A. 26 22 00 – Low-Voltage Transformers
- B. 26 24 13 – Switchboards
- C. 26 24 16 – Panelboards
- D. 26 28 16 – Enclosed Switches and Circuit Breakers
- E. 26 29 13 – Enclosed Controllers
- F. 26 29 23 – Variable-Frequency Motor Controllers
- G. 26 36 00 – Transfer Switches

**1.3 REFERENCES**

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
  - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
  - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
  - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
  - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
  - 6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
- B. American National Standards Institute (ANSI):
  - 1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
  - 2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
  - 3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
  - 4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents
- C. The National Fire Protection Association (NFPA)
1. NFPA 70 - National Electrical Code, latest edition
  2. NFPA 70E – Standard for Electrical Safety in the Workplace
  3. Submittals for review/approval
- D. The short-circuit and protective device coordination studies shall be submitted to the Design Professional prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Design Professional may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

#### 1.4 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies, where required, shall be provided on CD in PDF format.
- B. A preview of the report shall be submitted to the Design Professional indicating short circuit calculations and arc flash levels prior to any electrical gear being released.
- C. The report shall include the following sections:
1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
  2. Descriptions, purpose, basis and scope of the study
  3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
  4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
  5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
  6. Incident energy and flash protection boundary calculations
  7. Study shall include closed transition operation of automatic transfer switches, main-tie-main switchgear and/or generator paralleled with utility and worst-case short circuit rating shall be included in analysis for each piece of equipment. The closed transition and normal operation short circuit ratings shall both be used to explore the worst-case arc fault rating for each piece of electrical equipment.
  8. Comments and recommendations for system improvements, where needed
  9. Executive Summary including source of information and assumptions made

## **1.5 QUALIFICATIONS**

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies with a minimum of 5 years of recent experience performing similar analyses. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

## **PART 2 - PRODUCTS**

### **2.1 STUDIES**

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or third party Engineering Services Organization. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the motor control centers and power distribution panelboards. The study shall also include variable frequency drives, disconnect switches, harmonic filters, power factor correction equipment, transformers, electrical distribution equipment and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

### **2.2 DATA COLLECTION**

- A. Contractor shall furnish all field data as required by the power system studies. The Design Professional performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future utility supplies, motors, and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.
- D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

### **2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY**

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.
- B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.
- C. Provide the following:
  - 1. Calculation methods and assumptions

2. Selected base per unit quantities
  3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
  4. Source impedance data, including electric utility system and motor fault contribution characteristics
  5. Typical calculations
  6. Tabulations of calculated quantities
  7. Results, conclusions, and recommendations
- D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
1. Electric utility's supply termination point
  2. Incoming switchgear
  3. Unit substation primary and secondary terminals
  4. Low voltage switchboard or distribution panel
  5. Disconnect switch
  6. Variable frequency drive
  7. Standby generators and automatic transfer switches (include normal and emergency sides in parallel for closed transition switches)
  8. Branch circuit panelboards
  9. Other significant locations throughout the system
- E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings
  2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
  3. Adequacy of transformer windings to withstand short-circuit stresses
  4. Cable and busway sizes for ability to withstand short-circuit heating
  5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current
- G. In such cases where the short circuit study results in a requirement for greater AIC ratings than those listed in the contract documents, contact the design engineer for possible solutions. Current limiting fusible technology may be added to the electrical system to limit the amount of available fault current. The provider of the short circuit calculation shall recognize current limiting fusible technology and re-run the short circuit calculations.

## 2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
- B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

- E. Plot the following characteristics on the curve sheets, where applicable:
1. Electric utility's protective device
  2. Medium voltage equipment relays
  3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
  4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
  5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
  6. Conductor damage curves
  7. Ground fault protective devices, as applicable
  8. Pertinent motor starting characteristics and motor damage points
  9. Pertinent generator short-circuit decrement curve and generator damage point
  10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each switchboard, panelboard, etc.
  11. Zone selective interlocking: Where distribution equipment is equipped with zone selective interlocking, provide restrained and unrestrained settings for master and slave devices that are part of the zone.
  12. Energy reducing maintenance settings: Where distribution equipment is equipped with an energy reducing maintenance switch, provide normal and maintenance mode settings for the breaker.
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.
- G. The following equipment shall be selectively coordinated as required by the NEC.
1. UPS-1, ELP-1, ELP-2
  2. Any emergency life safety equipment
  3. ARC FLASH HAZARD ANALYSIS
- H. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018.
- I. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
- J. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- K. The Arc-Flash Hazard Analysis shall include all Medium Voltage, 480v, 240V and 208V locations.
- L. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 8 cal/cm<sup>2</sup>. Where values of greater than 8 calories per centimeter exist, advise Engineer on options for reduction of energy that exceed the contractual requirements.

- M. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- N. Study shall include maintenance switch settings where applicable.
- O. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- P. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2018.

## 2.5 REPORT SECTIONS

- A. Input Data:
  - 1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
  - 2. Short-circuit reactance of rotating machines with associated X/R ratios
  - 3. Cable type, construction, size, # per phase, length, impedance and conduit type
  - 4. Bus duct type, size, length, and impedance
  - 5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
  - 6. Reactor inductance and continuous ampere rating
  - 7. Aerial line type, construction, conductor spacing, size, # per phase, and length
- B. Short-Circuit Data:
  - 1. Source fault impedance and generator contributions
  - 2. X to R ratios
  - 3. Asymmetry factors
  - 4. Motor contributions
  - 5. Short circuit kVA
  - 6. Symmetrical and asymmetrical fault currents
- C. Recommended Protective Device Settings:
  - 1. Phase and Ground Relays:
    - a. Current transformer ratio.
    - b. Current setting.
    - c. Time setting.
    - d. Instantaneous setting.
    - e. Specialty non-overcurrent device settings.
    - f. Recommendations on improved relaying systems, if applicable.
  - 2. Circuit Breakers:
    - a. Adjustable pickups and time delays (long time, short time, ground).
    - b. Adjustable time-current characteristic.
    - c. Adjustable instantaneous pickup.
    - d. Recommendations on improved trip systems, if applicable.



- D. Incident energy and flash protection boundary calculations.
  - 1. Arcing fault magnitude
  - 2. Device clearing time
  - 3. Duration of arc
  - 4. Arc flash boundary
  - 5. Working distance
  - 6. Incident energy
  - 7. Hazard Risk Category
  - 8. Recommendations for arc flash energy reduction

### **PART 3 - EXECUTION**

#### **3.1 FIELD ADJUSTMENT**

- A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the Contractor.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify Owner in writing of any required major equipment modifications.

#### **3.2 ARC FLASH WARNING LABELS**

- A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:
  - 1. Location designation
  - 2. Nominal voltage
  - 3. Flash protection boundary
  - 4. Hazard risk category
  - 5. Incident energy
  - 6. Working distance
  - 7. Engineering report number, revision number and issue date
- C. Labels shall be machine printed, with no field markings
- D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
  - 1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
  - 2. For each motor control center, one arc flash label shall be provided
  - 3. For each low voltage switchboard, one arc flash label shall be provided
  - 4. For each switchgear, one flash label shall be provided
  - 5. For medium voltage switches one arc flash label shall be provided
- E. Labels shall be field installed by the Contractor.

### **3.3 ARC FLASH TRAINING**

- A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

**END OF SECTION 26 05 73**

## SECTION 26 09 13 - ELECTRICAL POWER MONITORING AND SUB-METERING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.
- B. Section 26 24 13 – Switchboards are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Sub monitoring meter system shall be used to monitor electrical usage internally. Each meter will be independently circuited to show usage by individual feeder metered. Each meter shall display electrical usage in kilowatt hours (kwh) and demand in kilowatts (kw). These measurements shall be displayed through an LCD screen on a centrally located housing unit.

#### 1.3 SUBMITTALS

- A. Submittal data shall include but not be limited to drawings and/or catalog cuts giving physical dimensions, wiring diagrams (control and power diagrams), construction materials, capacities, ratings, control sequencing, manufacturers recommended installation instructions, and any other pertinent information.
- B. Provide operating and maintenance manuals.

#### 1.4 TRAINING

- A. The Contractor shall provide two (2) hours of on-site training for the Owner's personnel advising of the proper methods of maintenance and operation of the equipment.
- B. Additional training time as deemed necessary by the Owner's authorized representative may be obtained from the supplier on a negotiated basis with the Owner.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. The meters shall meet all requirements of this section. Subject to compliance with requirements, acceptable manufacturers are as follows:
  - 1. E-Mon D-Mon (Basis of Design)
  - 2. Square D
  - 3. ABB/GE Industrial Solutions
  - 4. Eaton
  - 5. Electro-Industries/Gaugetech/Shark

## 2.2 METER REQUIREMENTS

- A. Meter shall be fully electronic with 4-line by 20-character backlit LCD display showing kWh, kW demand (with peak date and time), power factor per phase, real-time load in kW, Amps per phase and Volts per phase.
- B. Meter shall use 0-2 volt output split-core current sensors to allow paralleling and/or mounting up to 500 feet from the meter. Sensors shall be of split-core configuration to allow installation without powering down. Sensors shall be available from 100 amp to 3200 amp. Sensors shall be optionally available in solid-core configuration (100 & 200 amp.)
- C. Meter shall be field programmable for meter date/time and ID code for communication options.
- D. Meter shall provide installation diagnostics on display.
- E. Meter shall be enclosed in a NEMA 4X polycarbonate enclosure (standard) with padlocking hasp & mounting flanges for indoor/outdoor installation (stand-alone) with one 1 1/16" KO on bottom of enclosure. Optional MMU enclosure or heavy duty JIC steel enclosure, see drawings for enclosure type.
- F. Meter shall be UL Listed/CUL Listed to latest applicable standards for safety.
- G. Meter shall be certified by a nationally recognized independent test facility ANSI C12.20 (+/- 0.2% from 1% to 100% of rated load) specifications.
- H. Meter shall be provided with a non-volatile memory to maintain reading during power outages.
- I. Meter shall store interval data for kWh and kVARh for up to 72 days in first-in first-out format (Standard firmware.)
- J. Meter shall provide a load indicator to indicate real-time consumption levels for field testing and certification.
- K. Meter shall provide current sensor installation diagnostics indicator.
- L. Meter shall be enclosed in a heavy-duty JIC steel enclosure suitable for indoor installation. Meter enclosure provides a method of locking to prevent unauthorized access.
- M. Meter shall be available with the following communication protocols:
  - 1. BACnet (MS/TP)
  - 2. BACnet (IP)

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF METERS

- A. Install controllers as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Provide 3 pole breaker to allow termination of conductors for meter potential transformers.

**3.2 ADJUST AND CLEAN**

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.

**3.3 FIELD QUALITY CONTROL**

- A. Subsequent to wire/cable hook-up, energize controllers and demonstrate functioning of equipment in accordance with requirements, where necessary correct malfunctioning units.

**END OF SECTION 26 09 13**

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## SECTION 26 09 23 - LIGHTING CONTROL SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary for a complete operational lighting control system as required by the drawings and this section.
- B. This section applies to all work under this division. This shall include, but not necessarily be limited to, the following:
  - 1. Furnish, install, and terminate all system equipment and cabling as applicable and per drawings for a wired control system. No wireless control components.
  - 2. Furnish and install any cabinets, racks and cable management as required and as indicated.
  - 3. Furnish any other material required to form a complete and operational system.
  - 4. Provide As-Built drawings per Division 0 and/or Division 1 specification.
  - 5. Provide Owner training and testing documentation.
  - 6. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
  - 7. All work shall be performed in a neat, workmanlike manner in keeping with the highest standards of the craft.

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.
- B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.
- C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices.
- D. ASHRAE Compliance: Comply with ASHRAE 90.1-2010 section 9.
- E. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of workmanship shall take precedence, but such questions shall be referred to Design Professional for final decision.

#### 1.4 SUBMITTALS

- A. Submit manufacturer's product data literature for each lighting control component required. For occupancy sensors and related components, submit Manufacturer's device layout indicating recommended device placement, product data and project specific wiring diagrams. Submittals shall include the Sequence of Operation for each area of lighting control.

## **1.5 WARRANTY**

- A. The control system designated on the drawings and plans and herein specified shall be guaranteed to be free from original defects in both material and workmanship for a period of five (5) years. This warranty shall become effective starting the date of project substantial completion.

## **1.6 SYSTEM DESCRIPTION**

- A. System Architecture:
  - 1. The general building lighting control system shall be a networked lighting control system with centralized timing, control and programming functions with distributed control components.
  - 2. All system adjustments for time delays, high-level trim, low-level trim, fade times, blink warnings, photo sensor sensitivity, daylight setpoints, receptacle control time delays, vacancy mode, occupancy mode, etc. shall be programmable and adjustable without the use of a ladder.
  - 3. The Courtroom and Hearing Room Architectural Lighting Control Systems shall each be standalone, non-networked systems with touchscreen zone controls and preset scenes.
- B. Lighting control system for manual and automatic control of interior lighting systems.
  - 1. Space Control – Provide occupancy/vacancy control with manual occupant input as noted on the lighting control sequence schedule.
  - 2. Daylit Areas – All luminaires in the daylit zone shall be controlled separately from luminaires outside of daylit zones. Luminaires in the primary daylit zones shall be controlled separately from luminaires in secondary daylit zones.
  - 3. Daytime setpoints for total ambient illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
  - 4. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system will be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn fixtures back on at dimmed level, rather than turning full-on prior to dimming.
- C. Additional controls.
  - 1. Provide contact closure interface to the building automation system (BAS) for each controlled area. Control relays are to operate whenever occupancy is detected regardless of manual switch input or photosensor input. Coordinate with 23 09 00 – BUILDING AUTOMATON SYSTEM.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer: Subject to compliance with requirements, provide lighting control systems of one of the following:
  - 1. WattStopper Digital Lighting Management – DLM
  - 2. Hubbell Building Automation – NX
  - 3. Leviton – SectorFlex
  - 4. Cooper Greengate



5. Acuity Controls – nLight
6. Douglas Lighting Controls – Dialog

## **2.2 LINE VOLTAGE SINGLE / DUAL RELAY WALL SWITCH OCCUPANCY SENSORS (STAND-ALONE)**

- A. Dual Technology: Manual-ON, Automatic-OFF dual technology (passive infrared and ultrasonic) wall switch occupancy sensor. 0-10V dimmable where noted. Two zone where noted. Furnish the model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled. 120/277VAC rated.

## **2.3 WALL OR CEILING MOUNTED OCCUPANCY SENSOR**

- A. Description: Wall or ceiling mounted passive infrared (PIR), ultrasonic/microphonic, or dual technology occupancy sensor. Furnish the system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, occupancy sensors and accessories which suit the lighting and electrical system parameters.
- B. Specific sensors shall be selected based on the mounting height and device placement indicated as well as the performance characteristics of the manufacturer's proposed sensor. Where the manufacturer determines the controlled space exceeds the sensing range of the available sensors, additional sensors shall be included.
- C. Sensor shall be compatible with the environment installed.
  1. Indoor sensors in controlled environments shall be rated for use from 0 degrees C to 40 degrees C.
  2. Outdoor sensors shall be NEMA 3R or 4X, rated for use from -40 degrees C to 65 degrees C.
  3. Sensors in specialty areas (freezers, hose-down areas, etc.) shall be selected for the specific application.

## **2.4 LIGHTING CONTROL STATION**

- A. Description: Low voltage control station in multi-button configuration compatible with wall plates with decorator opening. Control stations shall include the following features:
  1. Engraving where indicated on the drawings.
  2. LED Pilot Lights: Required where indicated on Drawings.
- B. Control stations shall be able to function as noted below:
  1. Load and Scene button function may be reconfigured for individual buttons.
  2. Individual button function may be configured to Toggle, On only, Off only, Raise or Lower.
  3. Individual scenes may be locked to prevent unauthorized change.

## **2.5 ROOM CONTROLLERS**

- A. Room Controllers shall be provided to match the room lighting load and control requirements. The control units will include the following features:
  1. Dual voltage (120/277 VAC, 60 Hz)

- B. On/Off Room Controllers shall include:
  - 1. One or more relay configuration
  - 2. Relay controller listed for connection to receptacles, for occupancy-based control of plug loads within the space.
    - a. One relay configuration only, rated at 20A, 120VAC.
    - b. Automatic-ON/OFF configuration
  
- C. On/Off/Dimming Room Controllers shall include:
  - 1. One or more relay configuration
  - 2. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
  - 3. The following dimming attributes may be changed or selected via programming:
    - a. Establish preset level for each load from 0-100%
    - b. Set high and low trim for each load

## **2.6 PHOTSENSORS**

- A. Photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space.

## **2.7 EMERGENCY LIGHTING – AUTOMATIC LOAD CONTROL RELAY (ALCR)**

- A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
  - 1. 120/277 volts, 50/60 Hz. 20 amp rating
  - 2. Push to test button
  - 3. Auxiliary contact for remote test or fire alarm system interface
  - 4. Relays controlling 0-10V dimmed emergency lights shall include an auxiliary or integral relay device to open the control signal and force emergency lights to 100% light output.

## **2.8 CONTROLLED EMERGENCY LIGHTING IN LOCATIONS WITH ONLY EMERGENCY POWER (e.g. STAIRWELLS) – BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH (BCELT)**

- A. Emergency Lighting Control Unit – A UL 1008 listed device that receives a switched/dimmed circuit providing normal lighting to an area and an unswitched/uncontrolled emergency circuit. The unit is wired to the other normal power lighting circuit in the area for ON/OFF/Dim control. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
  - 1. 120/277 volts, 50/60 Hz. 20 amp rating
  - 2. Push to test button
  - 3. Auxiliary contact for remote test or fire alarm system interface

## 2.9 ARCHITECTURAL LIGHTING CONTROL SYSTEM

- A. Modular, customizable preset lighting control system that allows adjustment of multi-zone lighting levels and shades to meet occupant requirements in meeting rooms and conference rooms.  
Approved Manufacturers:

1. ETC Echo (Basis of Design)
2. Strand Lighting
3. Wattstopper
4. Crestron

- B. System accessories and capabilities

1. Touch screens
  - a. The Touchscreen protocols station shall provide control of up to 512 networked addresses or up to 512 local DMX addresses on a maximum of eighty (80) control zones.
  - b. The Touchscreen station shall operate using graphic buttons, faders, and other images on user programmable control pages.
  - c. Touchscreen stations shall consist of a minimum 7-inch, backlit liquid crystal display (LCD) with a minimum resolution of 800 by 400 pixels with a capacitive multi-touch interface.
  - d. The bezel shall have no visible means of attachment.
  - e. Touchscreen stations shall support surface, and flush mounting options
    - 1) Flush-mount to industry standard 3-gang back box
  - f. The Touchscreen shall be cULus Listed and CE Compliant.
  - g. The Touchscreen shall be FCC Compliant.
  - h. A maximum of 64 presets shall be retained in the event of loss of power.
  - i. A maximum of 4 internal sequences. Sequences shall record user-selected zone levels.
2. Room Controllers
  - a. Mechanical
    - 1) Room Controllers shall support wall and ceiling mounting, including installation in Plenum air return spaces, as well as flush-mounting with the appropriate cover.
    - 2) A removable front cover shall be provided.
    - 3) An internal safety cover shall prevent access to all line voltage (class1) wiring and components without limiting access to low voltage terminations, changing settings during commissioning, or manual control of relays.
    - 4) Room Controllers shall support onboard configuration without the use of software
      - a) A 16-position rotary switch shall assign zones to a space. Spaces one thru 16 shall be available .
      - b) A 16-position rotary switch shall assign a starting zone number of the room controller. Additional zones will be assigned sequentially thereafter.
      - c) The Room Controller shall support a contact input for use in UL 924 Emergency Systems.
      - d) A dry contact input shall provide triggering of an emergency condition.
      - e) Room Controllers shall provide station bus power for up to six control stations.

- f) All configuration buttons shall be fully accessible when the Room Controller is mounted, and the front panel is removed
  - 5) MicroSD shall be supported for the purpose of software upgrades
- b. Electrical
  - 1) Power Input shall support 120-277 Volts AC 47-63Hz for control electronics and each independent zone. Daisy Chain of an input to multiple control zones shall be supported
  - 2) Room Controllers shall provide an optional 20A single-phase normal sense feed input for UL924 Emergency Lighting Control Bypass
  - 3) A voltage barrier shall be available to separate normal and emergency circuits or lighting and plug loads when combined in a single controller.
  - 4) Room Controllers shall provide a 20A, fully rated, latching relay for each output
  - 5) A 0-10V dimming output per zone shall support 0-10V sink control
    - a) 0-10V wiring shall be fully isolated from ground within the Room Controller. Controllers without fully isolated 0-10V wiring shall not be acceptable
  - 6) Room Controllers shall support provided touch screen control communication and Class 2 power delivery methodology
  - 7) Room Controllers shall provide a three position terminal for power input to the control electronics. The control power input shall accept 6-14AWG wire and be clearly marked Line, Neutral and Earth Ground
  - 8) Each relay shall provide three screw terminals for line voltage power connection. Each terminal shall accept 6-14awg wire and be clearly labeled Input, Output and Thru. Controllers that do not support a single power input to multiple discrete relays, in any combination, shall not be deemed acceptable.
  - 9) Room Controllers shall provide wiring connections for a control station bus utilizing 16-26AWG screw terminal connections for signal +, signal-, and ESD ground.
  - 10) Room Controllers shall support 0-10 volt dimming control via terminals 16-26AWG terminals for 0-10V+ and 0-10V common wiring connections
  - 11) Room Controllers shall be UL and cUL LISTED and conform to UL 508 and UL 2043 (Plenum rated) standards
- c. Functional
  - 1) Room Controllers shall support automatic configuration to the most energy-efficient control scheme based on other devices installed in the same room or space.
    - a) Room Controllers shall support operation in Auto-on/Auto-off, Manual-on/Auto-off and Manual-on/Manual-off modes based on the connected control devices without the need for manual configuration
  - 2) Upon loss of power, Room Controllers shall return to their last state when power returns
  - 3) Room Controllers shall be available in 4 or 8 zone configurations with a 20A, fully-rated, relay output and 0-10V dimming output per zone
  - 4) Room Controllers shall be UL924 LISTED for emergency lighting circuits and shall activate only the selected outputs. Excluded loads shall be shed and not produce output during emergency conditions
  - 5) Room Controllers shall support commissioning without the use of software or specialty configuration tools. Controllers that require software for configuration shall not be acceptable.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install components as indicated on the drawings and as called for below.
- B. Low-voltage lighting control cables shall not share raceway or cable tray with telecommunications wiring. All cable shall be neatly routed and tie-wrapped to structural components. Excess wire shall be neatly coiled and secured to structure. Under no circumstances shall cable be supported by piping, conduit, ductwork, ceiling tile, or ceiling support wires. Cable shall be neatly routed in line with building lines.
- C. Provide a 8' coil of cable at each ceiling mounted device for ease of relocation if conflicts arise.
- D. Where concealed in walls or ceilings, lighting control cable shall be installed in conduit. Refer to 26 05 22 - Raceways and Boxes for Electrical Systems.
- E. All low-voltage lighting control cables shall be plenum rated.
- F. Where devices are installed in finished locations without ceilings, lighting control cables shall be installed in conduit.
- G. Where installed above accessible ceiling, all components shall be located in easily accessible areas. Any controller located in an area above a non-removable ceiling tile or where obstructed by piping or duct work shall be relocated. All locations shall be recorded on as-built drawings.
- H. Low voltage lighting control cable shall not use the same conduit sleeves as fire alarm or telecommunications cable. Provide dedicated sleeves. Where installed within non-accessible permanent construction or in exposed areas, provide continuous raceway to accessible location.
- I. It is the Contractor's responsibility to determine the ceiling type for each space and provide accessories as required for installation of devices in ceiling.
- J. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
- K. It is the Contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative at the Owner's facility to verify placement of sensors and installation criteria.
- L. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- M. Contractor is responsible to arrange a coordination meeting with the Division 23 Building Automation System contractor to coordinate dry contact interface of the systems.
- N. Occupancy Sensors shall be installed in accordance with manufacturer's instructions.
  - 1. Where devices are directional, devices shall be placed to sense occupancy of the area controlled by the device.

- O. Photosensors shall be installed in accordance with the manufacturer's requirements.
  - 1. Open loop sensors shall be placed to sense only the natural light entering the space with no artificial light component.
  - 2. Closed loop sensors shall be placed within the zone of controlled light. Closed loop sensors shall be placed and oriented to sense the light level on the work plane. Do not located where the sensor is blocked or illuminated by suspended light fixtures or other objects within the space.
- P. Calibrate all sensor time delays and sensitivity to provide proper detection of occupants and energy savings.
  - 1. Adjust time delay so that controlled area remains lighted for 15 minutes after occupant leaves area or as indicated in the Sequence of Operations.
  - 2. Adjust lighting system to provide maximum lighting levels as indicated on the drawings.
- Q. Provide 120V or 277V circuits as required for lighting control components.
- R. Provide network information jacks as required for lighting control system.
- S. Install emergency lighting control units (ELCU) in accordance with manufacturer's requirements.
  - 1. ELCU shall be located in an accessible location to allow access to the test button. Where ELCU is not accessible from an 8' step ladder, install remote test button.

### **3.2 FACTORY COMMISSIONING**

- A. Upon completion of the lighting control(s) installation, the lighting control system (all sensors and control equipment) shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system. The electrical contractor shall modify sensor locations and wiring as directed by the factory technician as required to achieve required functionality.
- B. Upon completion of the lighting control system fine tuning the factory authorized technician shall provide the proper training to the Owner's personnel in the adjustment and maintenance of the sensors.
- C. Re-commissioning. After 90 days from Owner occupancy, review system performance with the Owner and recalibrate all sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report of re-commissioning activity.
- D. Provide written or computer-generated documentation on the commissioning of the system including room by room description. Report to include:
  - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
  - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
  - 3. Load Parameters (e.g. blink warning, etc.)

### **3.3 TRAINING**

- A. Provide three (4) two-hour training sessions for the Owner. The first training session is to be at the time of initial system startup of the general building lighting control system. The second session is to be post-occupancy. The third will be to cover the Architectural Lighting Control System. The fourth session is to be used at Owner's discretion. The training is to include, but not limited to the following:
1. Detailed review of the system architecture, individual components, and wiring requirements.
  2. System programming method included examples and demonstrations. These are to include adjustments for time delays, high-level trim, low-level trim, fade times, blink warnings, receptacle control time delays, vacancy mode, occupancy mode, etc.
  3. Occupancy sensitivity adjustments for both PIR and ultrasonic setting, adjustments for an automatic learning mode and the ability to disconnect, and selection between PIR and Ultrasonic modes for dual technology devices.
  4. System troubleshooting including types of component failures, associated system failure and repair/replacement and reprogramming procedures.

### **3.4 SPARE PARTS**

- A. Spare Parts: Provide the following list of spare equipment (for each type used) to Owner to match equipment used in project.
1. Occupancy Sensor– quantity: 2 of each type installed
  2. Room Controller, 2-zone 0 – 10V – quantity: 2
  3. Room Controller, one zone – quantity: 2
  4. Photosensor – quantity: 2 of each type installed.
  5. Control Cables – quantity: 100'
  6. Control Station, - Quantity: 2 of each type installed
  7. Any specialty tool required for programming - Quantity: 1

**END OF SECTION 26 09 23**

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## SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install transformers as specified in this section and as called for on the drawings.
  - 1. Dry-type Transformers.

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.
- B. NEMA Compliance: Comply with applicable portions of NEMA Std Pub Nos. TR 1 and TR 27 pertaining to power/distribution transformers.
- C. ANSI/IEEE Compliance: Comply with applicable ANSI/IEEE standards pertaining to power/distribution transformers.
- D. ANSI/NEMA Compliance: Comply with NEMA Std ST 20; "Dry Type Transformers for General Applications".
- E. UL Labels: Provide distribution transformers which have been UL listed and labeled.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data including rated KVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and certification of transformer performance efficiency at indicated loads, percentage regulation at 100% and 80% power factor, no load and full load losses in watts, % impedance, hot spot and average temperature rise above 40 deg. C. ambient, sound level in decibels, and standard published data.
- B. Shop Drawings: Submit manufacturer's drawings indicating dimensions, and weight loadings for transformer installation.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):
  - 1. Schneider Electric/Square D (Basis of Design)
  - 2. ABB/GE Industrial Solutions

3. Eaton
4. Siemens

## **2.2 POWER/DISTRIBUTION TRANSFORMERS**

- A. General: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
- B. Dry Type Distribution Transformers: Provide factory assembled, general purpose, air cooled, dry type distribution transformers where shown; of sizes, characteristics, and rate capacities indicated. Provide primary windings with 6 taps; 2, 2 1/2% increments above full rated voltage and 4, 2 1/2% increments below full rated voltage for de energized tap changing operation. Limit transformer surface temperature rise to maximum of 65 deg.C. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections. Insulation class of 220 deg. C, UL Component recognized insulation system. Limit terminal compartment temperature to 75 deg.C when transformer is operating continuously at rated load with ambient temperature of 40 deg.C. Cushion mount transformers with external vibration isolation supports; sound level ratings as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall mounting.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF TRANSFORMERS**

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- C. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.
- D. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- E. Install units on vibration mounts; comply with manufacturer's indicated installation method if any.
- F. Grounding: Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground, for transformers as indicated.
- G. Transformers shall be connected to the raceway system with flexible conduit.
- H. Testing: Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

**END OF SECTION 26 22 00**

## SECTION 26 24 13 - SWITCHBOARDS

### PART 1 - ART 1 - GENERAL

#### 1.1 1.01 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install switchboards as specified in this section and as called for on the drawings.
- B. Types of switchboards in this section include the following:
  - 1. Dead front Front Accessible Only Distribution.
    - a. Circuit Breaker Switchboards.

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical switchboards.
- B. UL Labels: Provide switchboards which have been UL listed and labeled.
- C. ANSI/IEEE Compliance: Comply with ANSI/IEEE standards pertaining to power switchboard assemblies.
- D. NEMA Compliance: Comply with applicable portions of NEMA Stds. Pub. No. 2, "Dead front Distribution Switchboards"; No. PB 2.1, "Instructions for Safe Handling, Installation, Operation and Maintenance of Switchboards".

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on switchboards including, but not limited to the following: voltages, number of phases, frequency, and short circuit and continuous current ratings. Provide manufacturer's application data for main and branch circuit breakers, sections, main bus, and insulation level.
- B. Shop Drawings: Submit dimensioned drawings of switchboards showing accurately scaled basic dimensions including auxiliary compartments, section components, and combination sections.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
  - 1. Schneider Electric/Square D (Basis of Design)
  - 2. ABB/GE Industrial Solutions

3. Eaton
4. Siemens

## **2.2 EQUIPMENT SECTIONS AND COMPONENTS**

- A. General: Except as otherwise indicated, provide switchboards of types, sizes, characteristics, and ratings indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. AC Dead Front Distribution Switchboards: Provide factory assembled, dead front, front accessible only, metal enclosed, self supporting secondary power switchboards, of types, sizes and electrical ratings and characteristics indicated; consisting of panel (vertical) units, and containing circuit breakers and/or fusible switch assemblies of quantities, ratings and types indicated. Provide aluminum main bus and connections to switching devices of sufficient capacity to limit rated continuous current operating temperature rise to 54 degrees F (12 degrees C), and 90 degrees F (32 degrees C) for circuit breaker branches; with main bus and tap connections tin plated and tightly bolted for maximum conductivity. Brace bus for short circuit stresses up to maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Prime and paint switchboard with manufacturer's standard finish and color. Provide individual panel (vertical) units suitable for bolting together at project site. The switchboard framework shall consist of steel channel sills bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. The framework is to be formed of code gauge steel, rigidly welded together to support all cover plates, bussing and component devices. Each switchboard section shall have an open bottom and an individual removable top plate for installation and termination of conduit. Top and bottom conduit areas are to be clearly shown and dimensioned on the shop drawings.
- C. Bussing: Provide switchboard bussing with sufficient cross sectional area to fulfill UL Standard 891 pertaining to temperature rise. Construct through bus of plated aluminum with ampacity rating of 1200 amperes or greater, and with minimum short circuit rating of 50,000 RMS symmetrical amperes.
- D. Metering: Provide metering compartments for CT's, PT's and instrument transfer switches for meters as defined in section 26 0913. Connect meters for sequence metering; mount meters in front door. Install meter wiring and lacing with flexibility at hinged edge of meter in front mounting plates.

## **2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES**

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully-connected rating to meet available fault currents.
  1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A to 600A.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers for breakers 800A frame and larger and for select emergency system circuit breakers. Circuit breakers to be provided with rms sensing and following field-adjustable settings:
  - a. Instantaneous trip pickup levels.
  - b. Instantaneous trip delay
  - c. Long- and short-time pickup levels.
  - d. Long- and short-time time adjustments.
  - e. Ground-fault pickup level, time delay, and I2t response where indicated.
  - f. Provide an Arc-Flash Reduction Maintenance switch for all circuit breakers 1200A and larger.
4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
  - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
  - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
  - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

#### **2.4 SURGE PROTECTIVE DEVICE (SPD)**

- A. Service Entrance SPD per Section 26 43 13 – Surge Protective Devices
- B. Provide 60A circuit breaker to connect SPD to bus.

### **PART 3 - PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF SWITCHBOARDS**

- A. Install switchboards as indicated, in accordance with manufacturer's written instructions, with recognized industry practices to ensure that switchboards comply with requirements of NEMA and NEC standards, and applicable portions of NEMA's "Standard of Installation".

#### **3.2 ADJUST AND CLEAN**

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.

**3.3 GROUNDING**

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent ground, for switchboards as indicated.

**3.4 FIELD QUALITY CONTROL**

- A. Prior to energization of circuitry, check all accessible connections to manufacturer's torque specifications.
- B. Prior to energization of switchboards, check with ground resistance tester phase to phase and phase to ground insulation resistance levels to ensure requirements are fulfilled.
- C. Subsequent to wire and cable hook ups, energize switchboards and demonstrate functioning in accordance with requirements.
- D. See Division 03 for concrete housekeeping pad provided by Contractor.

**END OF SECTION 26 24 13**

## SECTION 26 24 16 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install lighting panelboards and distribution panelboards as specified in this section and as called for on the drawings.
- B. Types of panelboards and enclosures in this section include the following:
  - 1. Lighting and appliance panelboards.
  - 2. Power distribution panelboards.

#### 1.3 QUALITY ASSURANCE

- A. Compliance: Comply with applicable UL safety standards pertaining to panelboards and accessories, and enclosures; provide units which have been UL listed and labeled.
- B. NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets and cutout boxes.
- C. NEMA Compliance: Comply with NEMA Stds. Pub. No. 250, "Enclosures for Electrical Equipment (1000 volt maximum)", Pub. No. 1, "Panelboards", and installation portion of Pub. No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of panelboard required. Include data substantiating that units comply with requirements.
- B. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground fault circuit interrupters and accessories.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
  - 1. Schneider Electric/Square D (Basis of Design)

2. ABB/GE Industrial Solutions
3. Eaton
4. Siemens
5. Branch Fuse Lighting Appliance Panelboards for Selective Coordination: Eaton, Mersen, FerrazShawmut

## 2.2 PANELBOARDS

- A. General: Except as otherwise indicated, provide panelboards, enclosures and components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information; equip with number of unit panelboard devices as required for complete installation.
1. All Multi-Section Panels: Same dimensions.
  2. Provide two keys for each panel.
  3. Provide copper ground bar.
  4. All panels shall have a designed short circuit rating label.
- B. Lighting and Appliance Panelboards:
1. Panelboard bus structure and main lugs or main breakers shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67. Bussing shall be distributed phase sequence type.
  2. The bus assembly shall be enclosed in a steel cabinet. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. The rigidity and gauge of steel to comply with UL Standard 50 cabinets. Provisions for additional circuit breakers shall be such that field addition to connectors or mounting hardware will not be required to add circuit breakers to the panelboards.
  3. If ground fault interrupting breakers (GFI), switched neutral or other special types of breakers require additional pole spaces, size of panel shall be increased accordingly to give the scheduled numbers of poles for spare breakers and blank spaces.
  4. Fronts shall include doors and have flush, stainless steel, cylinder tumbler type locks with catches and spring loaded door pulls. The flush lock shall not protrude beyond the front of the door. All panelboard locks shall be keyed alike. Fronts shall have adjustable indicating trim ring clamps which shall be completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuitry directory frame and card with a clear plastic covering shall be provided on the inside of the door.
  5. Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for conductor specified.
  6. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule. Series connected interrupting ratings are not acceptable. This short circuit current rating shall be established by testing with the overcurrent devices mounted on the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per Underwriters Laboratories Standard UL 67. The source shall be capable of applying the specified panelboard short circuit current or greater. Testing of panelboard overcurrent devices for short circuit rating only while individually mounted is not acceptable. Also, testing of the bus structure by applying a fixed fault to the bus structure alone is not acceptable. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.
  7. Bus Bar: Aluminum or Copper.



8. Provide two 1" C and three 3/4" C stubs out of all flush mounted panelboards to accessible ceiling space.
9. Panelboards shall have door-in-door covers.
10. Branch Fused Disconnect Type (where indicated on drawings)
11. Visible circuit ON/OFF indication with colored and international symbol markings.
  - a. Open fuse indication via permanently installed neon indicating light.
  - b. UL and cUL listed 600Vac/200kA voltage/short-circuit current rating, load-break disconnect with amp ratings.
  - c. Finger-safe component with trim installed.
  - d. Mechanical interlock fuse and disconnect to prevent fuse removal while fuse terminals are energized.
  - e. No special tools required for fuse removal.
  - f. Bolt-on style bus connectors.
  - g. Clearly mark device housing with device amperage.
  - h. Provide permanently installed lockout means on the device for lockout tagout procedures. Provide permanently installed means for locking device in the ON position.
  - i. Provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 60A, 100A.

C. Power Distribution Panelboards; Circuit Breaker Type:

1. Panelboards to be used for main circuit distribution and power circuit distribution shall be similar to lighting panelboards with the following additions:
  - a. Cabinet doors over 48" long shall be equipped with three point latch and vault lock. End walls shall be removable.
  - b. Main lugs or main breakers shall be barriered on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall be barriered.
  - c. When required, panelboards shall be suitable for use as service equipment.
  - d. Bus Bar: Copper.

## 2.3 CIRCUIT BREAKERS

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Circuit Breakers - Branch Circuit Panelboards:
  1. Branch circuit breakers up to 150 amperes shall be Square D Type QOB or equal. Breakers shall be bolt-on type toggle action with quick-make, quick-break mechanism. Trip indication shall be clearly shown by the breaker handle taking a position between on and off when the breaker is tripped. All multi-pole breakers shall be single-operated handle, internal common trip. Breakers having handle ties but not factory labeled "common trip" will be rejected. UL Class A ground fault circuit protection shall be provided on 120V AC branch circuits as specified on the plans or panelboard schedule. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" at 120V AC and carry the SWD marking. Tandem or "piggyback" breakers providing two circuits from one pole space are prohibited.

C. Circuit Breakers - Distribution Panelboards:

1. Molded case circuit breakers shall be rated 15 through 2500 amperes. Breakers covered under this specification may be applied in switchboards, panelboards, motor control centers, combination motor starter, busway plug-in units or individual enclosures.
2. Molded case circuit breakers shall have overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle indication. Two and three-pole breakers shall be common trip. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Units shall be constructed to accommodate the supply connection at either end. Operating handles shall assume a center position when tripped. All breakers shall be calibrated for operation in an ambient temperature of 40 deg. C.
3. Breakers shall have removable lugs. Lugs shall be UL listed for copper/aluminum conductors. Breakers shall be UL listed for installation of mechanical screw type lugs.

**2.4 SURGE PROTECTIVE DEVICE (SPD)**

- A. Provide 60A circuit breaker to connect SPD to bus.
- B. Branch Panel SPD per Section 26 4313 – Surge Protective Devices.

**PART 3 - EXECUTION**

**3.1 INSTALLATION OF PANELBOARDS**

- A. General: Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Securely anchor panelboards to structure and make feeder and branch circuit connections as indicated in specifications and on the drawings.
- C. Each panelboard directory shall be typewritten to identify the load fed by each circuit. Spare breakers and circuits to be left blank with circuit breaker in off position.

**END OF SECTION 26 24 16**

## SECTION 26 27 26 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 00 10 - Electrical General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide materials, equipment, labor and supervision necessary to install wiring devices as required by the drawings and this section.
- B. Types of wiring devices this section include the following:
  - 1. Straight blade receptacles
  - 2. GFI receptacles
  - 3. Wall switches
  - 4. Wiring device accessories
  - 5. Wall box dimmers

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.
- B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.
- C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices.

#### 1.4 SUBMITTALS

- A. Submit manufacturer's name and product data literature for each type of wiring device required.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
  - 1. Hubbell, Inc.
  - 2. Leviton Manufacturing Co., Inc.
  - 3. Pass & Seymour / Legrand

#### 2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Device Color:
  - 1. Device color shall be selected by the architect at the time of submittal review.

2. Device color may not be consistent throughout the building. Select areas may require special colors. Refer to Architectural elevations and finishes.
  3. Device model numbers indicated below to not include a color suffix. Model numbers listed do not indicate brown device color.
  4. Where a device is shown connected to an emergency circuit, it shall have a "red" body.
- B. Modular Connectors: Devices that are manufactured for use with modular plug-in connectors (snap connect, plug tail, etc.) may be substituted. Plug in connectors shall meet the following conditions:
1. Connectors shall comply with UL498 and shall be made with stranded building wire.
- C. Tamper Resistant:
1. Devices marked 'TR' shall be tamper resistant. Provide tamper resistant versions of the model specified.
  2. Refer to Part 3 - Execution section for required locations.
- D. Weather Resistant:
1. Devices located at exterior and wet locations shall be weather resistant. Provide weather resistant versions of the model specified.
  2. Refer to Part 3 - Execution section for required locations.

### **2.3 STRAIGHT BLADE RECEPTACLES**

- A. Heavy Duty Convenience Receptacles 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Hubbell HBL5361 (simplex), 5362 (duplex).
  2. Pass & Seymour 5361 (simplex), 5362 (duplex)
  3. Leviton 5361 (simplex), 5362 (duplex)

### **2.4 GFCI RECEPTACLES**

- A. Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596. Configuration 5-20R. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Self-testing, 4 to 6mA trip. Hubbell is basis of design. Other listed manufacturers are acceptable.
1. Heavy duty standard. Hubbell GFRST20
  2. Heavy duty tamper resistant: Hubbell GFTRST20
  3. Heavy duty weather resistant. Hubbell GFWRST20
  4. Heavy duty tamper resistant and weather resistant: Hubbell GFTWRST20
  5. Heavy duty faceless. Hubbell GFBFST20

### **2.5 WALL SWITCHES**

- A. Heavy duty industrial grade switch. Comply with NEMA WD 1, and FS W-S-896. Hubbell is basis of design. Other listed manufacturers are acceptable.
1. Single pole toggle light switch 20 amp, 120 277 volt, Hubbell #1221 series.
  2. Double pole toggle light switch 20 amp, 120 277 volt, Hubbell #1222 series.
  3. Three way toggle light switch 20 amp, 120 277 volt Hubbell #1223 series.

4. Four way toggle light switch 20 amp, 120/277 volt, Hubbell #1224 series.
5. Double pole double throw center off light switch 20 amp, 277 volt, Hubbell #1386 series.
6. Momentary contact switch 15 amp, 120/277 volt, Hubbell #1556 series.
7. Timer Switch 15 amp, 120/277 volt, Hubbell #DT2000W.

## 2.6 WIRING DEVICE ACCESSORIES

### A. Cover Plates:

1. Stainless steel, smooth metal, Type 302 for all Courtrooms, Hearing Rooms and the County Boardroom. All other spaces Smooth High-Impact Thermo plastic (nylon, unbreakable), Hubbell NP Series or equal.
2. Plates for surface outlets shall be of the raised cover type utilizing 4" square boxes.
3. Outlets Installed Outdoors and in Wet Locations:
  - a. Weatherproof Flip Cover ("WP"): Weatherproof device covers shall consist of cast metal cover plate and cap over each opening. The cap shall be permanently attached to the cover plate by a spring hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
    - 1) Horizontally mounted devices shall have cover plate aligned for same mounting, equal to Hubbell CWP series.
    - 2) Vertically mounted devices shall have cover plate aligned for same mounting, equal to Hubbell WP series.
  - b. Weatherproof Cord and Plug Cover ("WPD"): Extra duty, while-in-use, NEMA 3R cover. Heavy-duty die cast metal construction, UL 514D. Hubbell WP26 series or equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF WIRING DEVICES

- A. Install wiring devices as indicated on the drawings and as called for below.
- B. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
- C. In masonry walls, switches and receptacle heights shall be adjusted as required so outlets are at nearest mortar joint to specified height.
- D. Where light switches are located adjacent to doors, they shall be installed on "knob" side of door, unless indicated otherwise.
- E. Switched duplex receptacles shall be wired so that only the top receptacle is switched; the remaining receptacle shall be unswitched.
- F. All GFI type receptacles shall be installed where GFI notation is shown on plans. No downstream protection of receptacles will be allowed from load side of other GFI type receptacles unless specifically noted on drawings.
- G. All GFI receptacles shall be accessible for testing. Where a GFI receptacle is located behind equipment, a faceless GFCI device shall be provided in an adjacent accessible location.

- H. All receptacles within 6' of the edge of a sink shall be GFI type, Contractor shall notify Engineer prior to installation if the drawings do not indicate these as GFI.
- I. Prior to roughing in outlet boxes, Contractor shall verify from general construction drawings, door swings, type of wall finishes and locations for counters and work benches.
- J. Receptacles shall be installed with ground terminal up. Horizontal receptacles shall be installed with the grounded (neutral) terminal up.
- K. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
- L. All receptacles installed in damp and wet locations shall be weather resistant.
- M. All non-locking 15A and 20A receptacles in the following locations shall be tamper resistant regardless of mark on plans:
  - 1. Public waiting areas & lobbies
  - 2. Public corridors

**END OF SECTION 26 27 26**

## SECTION 26 28 16 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. In general, disconnect switches and circuit breakers are indicated on the drawings, and it shall be the Electrical Contractor's responsibility to furnish and install all disconnect switches for equipment and motors furnished by them, and for equipment and motors furnished by others.
- B. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install equipment as specified in this section and as called for on the drawings. All components necessary for a complete installation including, but not limited to fuses, fuse clips, channel strut support, lugs, etc. are to be included by the contractor.
- C. Types of switches and circuit breakers in this section include the following:
  - 1. Fusible and non-fusible disconnect switches.
  - 2. Motor rated toggle disconnect switches
  - 3. Plug fuse disconnect switches
  - 4. Enclosed circuit breakers
  - 5. Fuses

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical motor and circuit disconnect switches.
- B. UL Compliance and Labeling: Provide motor and circuit disconnect switches which have been UL listed and labeled.
- C. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub. No. KS 1.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of motor and circuit disconnect switch required.

### PART 2 - PRODUCTS

#### 2.1 FUSIBLE AND NON-FUSIBLE DISCONNECT SWITCHES

- A. Manufacturers:
  - 1. Schneider Electric/Square D (Basis of Design)
  - 2. ABB/GE Industrial Solutions
  - 3. Eaton

4. Siemens

- B. Fusible Switch: NEMA KS 1, Heavy Duty, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Non-fusible Switch: NEMA KS 1, Heavy Duty, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors. Provide for all 4-wire feeds.
  - 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open. Provide for all switches on the load side of a VFD and elevator disconnects.
- E. Disconnects installed indoors shall have NEMA 1 enclosures, disconnects installed outdoors or in wet locations shall have raintight NEMA 3R enclosures. Disconnects specifically identified by '4X' shall have a stainless steel NEMA 4X enclosure.
- F. Disconnects used for service entrance equipment shall be labeled for such use.
- G. Disconnects that are part of a photovoltaic system shall be listed for such use.
- H. All disconnects shall be of the fuse type, except where drawings indicate non fuse type (NF).
- I. Safety switches in mechanical rooms shall be NEMA 12 type.

**2.2 MOTOR RATED TOGGLE DISCONNECT SWITCHES**

- A. Manufacturers:
  - 1. Schneider Electric/Square D (Basis of Design)
  - 2. ABB/GE Industrial Solutions
  - 3. Eaton
  - 4. Siemens
  - 5. Hubbell
  - 6. Pass & Seymour
- B. Description: Motor rated non-fused switch for ON-OFF control of single or three-phase motors and equipment where overload protection is not required. Square D class 2510, type K or equal.
  - 1. Compact construction.
  - 2. NEMA 1 enclosure or as noted with handle guard provision able to be locked in the open position.
  - 3. Two or three pole configurations, 600V rated.

**2.3 PLUG FUSE DISCONNECT SWITCHES**

- A. Manufacturers:
  - 1. Bussmann



- B. Description: Box cover switch and fuse holder for Fustat plug fuses.
  - 1. Bussmann type SSY, handy box mounted.
  - 2. 120V, single pole, 15A rated
  - 3. Plug fused sized for individual motor.

## 2.4 ENCLOSED CIRCUIT BREAKERS

- A. General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully connected rating to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A to 600A.
  - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 3. Electronic trip circuit breakers for breakers 800A frame and larger and for select emergency system circuit breakers. Circuit breakers to be provided with rms sensing and following field-adjustable settings:
    - a. Instantaneous trip pickup levels.
    - b. Instantaneous trip delay
    - c. Long- and short-time pickup levels.
    - d. Long- and short-time time adjustments.
    - e. Ground-fault pickup level, time delay, and I<sup>2</sup>t response where indicated. All circuit breakers on 4-wire systems indicated to have ground-fault sensing shall include neutral current transformers.
    - f. Provide an Arc-Flash Reduction Maintenance switch for all circuit breakers 1200A and larger.
  - 4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  - 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  - 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

- C. Breakers shall have removable lugs. Lugs shall be UL listed for copper/aluminum conductors. Breakers shall be UL listed for installation of mechanical screw type lugs.
- D. Enclosed circuit breakers installed indoors shall have NEMA 1 enclosures, enclosed circuit breakers installed outdoors or in wet locations shall have raintight NEMA 3R enclosures.
- E. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors. Provide for all 4-wire feeds.
  - 3. Permanent provision for locking in the open position,
- F. Enclosed circuit breakers used for service entrance equipment shall be labeled for such use.

## **2.5 FUSES**

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.
- B. Motors Above One-half (1/2) Horsepower: For fuse rating 600 amperes or less, dual element time delay, Type FRN(S)-R, with interrupting rating of 200,000 amperes RMS. Size fuses per Article 430 of the National Electric Code.
- C. Motors One-half (1/2) Horsepower or Less: Single phase 150 volts or less, Fustat fuses for motor running protection sizes. Single phase or three phase over 150 volts, Fustron fuses for motor running protection, with interrupting rating of 100,000 RMS. Size fuses per Article 430 of the National Electric Code.
- D. Fuses for all feeders, branch circuits, motors and other equipment shall be selected in types and ratings in accordance with NEC to provide a coordinated system of overcurrent protection, thus in case of a fault or harmful overload, only the fuses nearest the fault or overload will open.
- E. Provide one spare set of three (3) of each size and type of fuse used on project.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

- A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Install disconnect switches as follows:
  - 1. Heavy Duty Switches. All applications including motors, feeders, service entrance, and equipment.
  - 2. Motor Rated Toggle Disconnect Switch. May be used for motors and equipment 30 Amps or less where fuse protection is not required. Applications include heat pumps, pumps and fans, where not downstream of a VFD,

3. Plug Fuse Disconnect Switch. May be used for 120 Volt motors, 1/2hp or less including furnaces, circulation pumps, and exhaust fans.
  4. Enclosed Circuit Breakers: Where specifically indicated.
- C. Install disconnect switches used with motor driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.
  - D. Install fuses in switches protecting equipment rated in accordance with nameplate maximum overcurrent protection noted on the equipment.
  - E. Where a disconnect switch is installed downstream of a VFD, the disconnect switch shall be provided with make-before-break auxiliary contacts with control wires to the VFD to signal the VFD.
  - F. Maintain all clearances required the by the National Electrical Code.
  - G. Where NEMA 3R equipment is specified for use in interior locations, installation shall maintain the weatherproof listing of the equipment.

**END OF SECTION 26 28 16**

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## SECTION 26 29 13 - ENCLOSED CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Extent of motor starter work is indicated by drawings and schedules.
- B. Types of motor starters in this section include the following:
  - Magnetic
  - Combination
  - Reversing
  - Fractional HP Manual
  - Integral HP Manual
  - Solid state reduced voltage
  - Wye delta reduced voltage
  - Auto transformer reduced voltage

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of motor starters.
- B. UL Compliance and Labeling: Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units which have been UL listed and labeled.
- C. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to motor controllers/starters and enclosures.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on motor starters.
- B. Shop Drawings: Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts and spatial relationship to associated motors, and connections to electrical power panels and feeders.
  - 1. Include electrical ratings, dimensions, mounting, material, running overcurrent protection, branch circuit overcurrent protection, wiring diagrams, starting characteristics, interlocking, and accessories.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):
  - 1. Schneider Electric/Square D (Basis of Design)

2. ABB/GE Industrial Solutions
3. Eaton
4. Siemens
5. Allen-Bradley

## **2.2 MOTOR STARTERS**

- A. General: Except as otherwise indicated, provide motor starters and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installer's option.
- B. Magnetic Starters with Thermal Overloads: Provide full voltage alternating current magnetic starters of types, ratings and electrical characteristics indicated; equip with thermal overload relays of the melting alloy type sized per manufacturer's recommendations for protection of the motor; electrical interlocks as required for the control sequences indicated; enclosure of NEMA type suitable for environmental conditions where installed; control transformer within each enclosure where required to provide 120 volt control voltage; manual reset on the door of each enclosure; selector switches, pilot lights, push buttons and other devices and accessories as shown on the drawings or otherwise required.
- C. Combination Starters: Provide full voltage alternating current combination starters, consisting of starters and disconnect switches mounted in common enclosures of types, sizes, ratings, and NEMA sizes indicated. Equip starters with features as described in B above. Operating handle for disconnect switch mechanism shall indicate and control switch position with enclosure door open or closed; capable of being locked in OFF position and mechanically interlocked to prevent opening unless switch within the enclosure is open. Construct and mount starters and disconnect switches in single NEMA type enclosure suitable for environmental conditions where installed.
- D. Fractional HP Manual Starters: Provide manual single phase fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with thermal overload relay of the melting alloy type for protection of 120 VAC motors of 1/2 HP and less. Provide starters with quick make, quick break trip free toggle mechanisms, green pilot lights, and with toggle operated handle with handle lock off; mount starter in NEMA type enclosure suitable for environmental conditions where installed.
- E. Integral HP Manual Starters: Provide manual motor starters for on off operation of small single phase and poly phase motors up to 10 HP, of types, ratings and electrical characteristics indicated. Equip with thermal overload relays of the melting alloy type sized per manufacturer's recommendations for proper protection of motor; green pilot light; and electrical interlocks as required for the control sequences indicated.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF MOTOR STARTERS**

- A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate with other work including motor and electrical wiring/cabing work, as necessary to interface installation of motor starters with other work.
- C. Install fuses in fusible disconnects.

**3.2 ADJUST AND CLEAN**

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.

**3.3 FIELD QUALITY CONTROL**

- A. Subsequent to wire/cable hook up, energize motor starters and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units.

**END OF SECTION 26 29 13**

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## SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Variable speed AC motor controllers and all power wiring. Control wiring and system control components by others.
- B. Variable speed AC motor controllers shall be of the "Variable/Adjustable Frequency" or "Inverter" type drives based on solid state electronics. The adjustable frequency AC drive shall convert 3 phase, 60 Hertz input power to an adjustable AC frequency and voltage 3 phase output for controlling the speed of any NEMA MG 1 Design B squirrel cage induction motor. The adjustable frequency drive shall have the following basic design:
  - 1. Converter - Converter shall consist of a modular assembly consisting of a diode rectifier and capacitor assembly which will first convert, then filter and maintain a fixed DC voltage source from the fixed voltage and frequency input.
  - 2. Inverter - Inverter shall consist of a modular assembly consisting of power semiconductors for generation of a sine-coded pulse width modulated (PWM) output waveform.
  - 3. Regulator - Regulator shall consist of a modular assembly. The regulator shall be fully digital and incorporate a microprocessor to control all inverter, converter, and external interface functions.
  - 4. Interface - Interface shall consist of terminal strips for all input and output signals.
- C. All control instrument components shall be electronic and of industrial control quality and furnished with variable speed motor controllers complete as outlined in these specifications and drawings.
- D. The variable speed motor controller supplier shall provide all necessary factory and/or field labor for complete calibration and adjustment of the adjustable frequency drives and control components, and shall be responsible for setting all control set points, operating sequences, and alarming systems within the specified control systems to produce the overall system performance as specified.

#### 1.3 SUBMITTALS

- A. Submittal data shall include but not be limited to drawings and/or catalog cuts giving physical dimensions, wiring diagrams (control and power diagrams), construction materials, capacities, ratings, control sequencing, manufacturers recommended installation instructions, and any other pertinent information.
- B. Provide operating and maintenance manuals.
- C. Provide recommended spare parts list and prices. Also, the address of the manufacturer's closest parts stocking location shall be provided.

- D. Include manufacturer's standard product warranty (for not less than a one year period) for replacement of materials and equipment.
- E. Submit electrical harmonics calculations to comply with criteria set forth in Electrical Harmonic Mitigation Requirements indicated below. See Electrical Documents for information about electrical distribution system and components to be used in study including kVA, impedance, panels serving VFDs, etc.

#### **1.4 START-UP SERVICE**

- A. The supplier of the variable speed motor controller shall have a factory trained service representative provide start up service and commissioning.
- B. Contractor shall coordinate controller parameters with other contractors.

#### **1.5 TRAINING**

- A. The supplier of the variable speed motor controller shall have a factory trained service representative provide eight (8) hours of on-site training for the Owner's personnel advising of the proper methods of maintenance and operation of the controller.
- B. Additional training time as deemed necessary by the Owner's authorized representative may be obtained from the supplier on a negotiated basis with the Owner.

#### **1.6 ELECTRICAL HARMONIC MITIGATION REQUIREMENTS**

- A. Provide harmonic mitigation equipment as necessary to comply with this section.
- B. Comply with IEEE 519-2014 requirements for voltage and current distortion limits at the point of common coupling.
  - 1. Voltage total harmonic distortion shall not exceed 5% of fundamental input voltage at full load and no individual harmonics greater than those listed in section 5.1 Table 1.
  - 2. Current total harmonic distortion shall not exceed 8% at full load and no individual harmonics greater than those listed in section 5.1 Table 2.
- C. Provide harmonic analysis at point of common coupling defined as follows: primary side of service transformer for current and secondary side of service transformer for voltage.
  - 1. Analysis shall assume the following:
    - a. Transformer loading of 75% of nameplate with 4.5% impedance.
    - b. Infinite utility fault capacity if actual utility fault capability is unknown.
    - c. Motors operating at 80% of nameplate current.
    - d. Total horsepower connected to a VFD should be used.
  - 2. Include VFDs for other equipment identified under other specification sections such as chillers, packaged equipment, elevators, etc. Coordinate with other contractors as necessary to obtain information.
- D. Contractor shall provide necessary documents and information to VFD manufacturer to facilitate study.

- E. Provide all input line reactors, bus reactors, harmonic filters, etc. necessary to meet IEEE 519 and include costs in base bid.
- F. Base VFD type on results of IEEE-519 study with minimum configuration as follows (NOTE: total horsepower connected to a VFD shall be used when calculating harmonic mitigating technology, e.g. (4)15HP fans = 60HP):
  - 1. Less than 40HP – 6 pulse drive with 5% reactor.
  - 2. 40HP up to 75HP – 6 pulse drive with 5% reactor and passive harmonic filter or 12 pulse drive.
  - 3. Larger than 75HP – 18 pulse drive or active front end filter.
  - 4. Engineered solution specific to the project requirements that employs harmonic mitigation equipment and is submitted for Engineer approval prior to bidding.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. The variable speed AC motor controllers shall meet all requirements of this section. Subject to compliance with requirements, acceptable manufacturers are as follows:
  - 1. Toshiba/Houston
  - 2. ABB
  - 3. Danfoss
  - 4. Yaskawa

### **2.2 CONTROLLERS**

- A. General: For the purpose of this Part, the word "controller" shall mean variable speed AC motor controller, i.e. VFD.
- B. The controller shall be mounted in a NEMA ventilated enclosure appropriate for environment. The enclosure size shall be adequate to dissipate the heat generated by the controller within the limits of the specified environmental operating conditions. The door shall be hinged, secured with latch. "Bolt-on" doors are not acceptable.
- C. Ambient service temperature rating shall be from 0oC to 40oC for normal operating conditions. The controller shall operate at less than 90% relative humidity non-condensing. The controller shall operate at an altitude less than 1000 meters (3300 feet) above sea level.
- D. Input power rating shall be 3 Phase, voltage as scheduled per drawings +/- 10%, 60 Hertz +/- 3%.
- E. The controller shall be mounted in a NEMA 12 enclosure.
- F. The controller shall have a door interlocked incoming AC disconnect with external operator handle which is capable of being locked in the "off" position. The disconnect shall shutdown all input power to both the drive and the bypass circuitry, where applicable.
- G. The controller shall have the input fused internally with standard fuses.
- H. Controller shall have an output frequency range of 5 to 120 Hertz. The frequency regulation shall be +/- .5% of maximum frequency.

- I. The controller shall provide thermal overload relays on the inverter output for motor protection for each motor controlled.
- J. The controller shall maintain power factor to .95 or greater throughout its speed range for each motor controlled.
- K. The controller shall have as a minimum the following protective features:
  - 1. Short circuit protection.
  - 2. Under/over voltage protection.
  - 3. Automatic restarting after a power outage or momentary overvoltage.
  - 4. Ground fault protection, but there shall be no automatic restart into ground fault.
  - 5. Overcurrent protection.
  - 6. Supply voltage phase loss protection.
  - 7. Over temperature protection.
  - 8. Start into rotating motor protection. The controller shall catch a spinning load without tripping.
- L. The controller shall be rated for 100% continuous current. The controller shall be capable of providing 110% of rated current for a minimum period of one minute. The controller shall have adjustable current limit. The controller shall have current limited stall prevention during acceleration, deceleration, and run conditions.
- M. The controller shall have process follower inputs for 4-20 mA. Provide bias and gain adjustments for the follower.
- N. The controller shall provide adjustable linear acceleration and deceleration control, each separately adjustable. The ramp time shall be adjustable from 0.1 to 30 seconds. Longer ramp times shall be optionally available.
- O. The controller shall provide maximum and minimum frequency control, each separately adjustable.
- P. The controller shall have internal manually operated bypass circuitry for direct line motor operation. Provide an inverter/line selector switch on the front panel to transfer the motor from the adjustable speed drive to the power line, or from the line to the inverter at zero speed. Motor protection and other safety devices shall be operative in both inverter and line modes.
- Q. Fault indicators shall indicate the following fault conditions:
  - 1. Overcurrent.
  - 2. Short circuit.
  - 3. Undervoltage.
  - 4. Overvoltage.
  - 5. Overtemperature.
  - 6. Regulator function error.
  - 7. Ground fault.

In addition to the fault indicators, the controller shall provide normally open Form C fault contacts to allow remote monitoring of drive conditions.

- R. The controller shall have as a minimum the following operator controls mounted on the front panel:
  - 1. Manual/Auto selector.

2. Start/Stop switch.
  3. Inverter/Line switch.
  4. Speed potentiometer.
  5. Fault reset.
  6. Speed Indicator.
- S. The controller shall provide adjustable carrier frequency.
- T. The controller shall have an internal line reactor and EMI/RFI filters.
- U. Controller shall have serial communications capability with the building automation system via BACnet protocol.

### **2.3 INPUT LINE REACTORS**

- A. Size per harmonic analysis with 5% minimum rating.
- B. Mount internal to VFD enclosure.
- C. Internal DC bus chokes are also acceptable if performance is equivalent to specified input line reactors.

### **2.4 PASSIVE HARMONIC FILTERS (WHERE REQUIRED BY IEEE 519 ANALYSIS)**

- A. Size inductors and capacitors to tune out harmonics from 6-pulse drives.
- B. Mount internal to VFD enclosure.
- C. Include contactor to take capacitor out of circuit if controller is operating at low power output while leaving inductor in circuit. Set point shall be field programmable and set to 50% initially.

### **2.5 ACTIVE FRONT END FILTERS (WHERE REQUIRED BY IEEE 519 ANALYSIS)**

- A. Size to tune out harmonics and supply sinusoidal output current waveform.
- B. Parallel units may be provided to meet load requirements.
- C. Unit(s) shall match kAIC rating of upstream equipment.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF CONTROLLERS**

- A. Install controllers as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate with other work including motor and HVAC controls work, as necessary to interface installation of controllers with other work.
- C. The controllers shall be mounted and installed on the mechanical equipment room walls whenever possible. When the controllers cannot be wall mounted, the controllers shall be installed on four-inch housekeeping pads. Installation of units directly on the floor will not be acceptable.

- D. Each controller shall have a dedicated raceway for the input power feeder, output power feeder and controls. Raceway shall be separated by at least 6" from other controller feeders and controls raceway.
- E. Where a disconnect switch is provided between the controller and the motor, provide control wiring to interlock the disconnect switch OPEN contact with the controller for controller shutdown.
- F. Provide 4" high concrete equipment pad for floor mounted controllers.
- G. Equipment manufacturer factory authorized service agent shall be responsible for on-site assistance to the temperature control contractor and the temperature control programmer with device addressing and confirming that the unit communicates with the Building Automation System as specified.

### **3.2 OPERATION**

- A. Manual/Auto System Operation
  - 1. Selector switch in MANUAL mode - operation shall be from the door mounted potentiometer and the system shall be operable from 0-100% on the potentiometer operating between the minimum and maximum speeds as set in the inverter.
  - 2. Selector switch in AUTO mode - operation shall be from the input follower signal, with output speed being proportional to the input signal. A remote set of Form C start/stop contacts (furnished by the Temperature Controls Contractor) shall control the inverter.
- B. Start/Stop
  - 1. Switch used to initiate command to start or stop the drive; operates in manual mode.
- C. Inverter/Line
  - 1. Selector switch in the LINE mode shall disconnect the adjustable frequency system and bypass for direct across-the-line motor operation to the 3 phase, 60 Hertz supply.
  - 2. Selector switch in the INVERTER mode shall disconnect the 3 phase, 60 Hertz supply and the system shall operate in the mode as established by the inverter Manual/Auto switch.
- D. Automatic Restart
  - 1. In the event of a loss of supply line power, or an overvoltage/undervoltage condition of more than 5%, or in the event of a shutdown signal from the temperature control or fire detection system, the system shall shut down. When line power is restored, the system shall automatically restart after a time delay, providing the start contact is a maintained contact in the closed position and all external interlocks are satisfied.
  - 2. For motors started frequently, the system shall provide start at almost zero RPM and gradually increase to required speed.

### **3.3 ADJUST AND CLEAN**

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.

- C. The carrier frequency shall be adjusted to optimize motor and VFD operation while reducing motor noise.

**3.4 FIELD QUALITY CONTROL**

- A. Subsequent to wire/cable hook-up, energize controllers and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units.

**END OF SECTION 26 29 23**

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## SECTION 26 32 13 - ENGINE GENERATORS

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.
- B. Section 22 15 17 – Facility Fuel-Oil Piping
- C. Section 23 21 13 – Hydronic Piping
- D. Section 26 36 00 – Transfer Switches.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish all equipment, materials, tools, labor and supervision necessary to install generators as specified in this section and as called for on the drawings.
- B. Types of standby generator system equipment required for project include the following:
  - 1. Diesel engine driven generators.
- C. The intent of these specifications is to establish a level of quality and desired function of the equipment specified.
- D. These specifications include furnishing and installing a continuously rated, for standby use, engine generator set delivered to the site complete with all necessary accessories as may be hereinafter set forth. The term "continuously rated for standby use" shall mean that the set will be for standby service but once started shall be capable of carrying a full load on a continuous basis for an indefinite period of time.
- E. Refer to Division 3 sections for concrete and grout work required in connection with engine generator sets.
- F. Above ground storage fuel tanks, piping and accessories required in conjunction with engine generator units are specified in Division 22 & 23 sections.

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with applicable standby generator requirements of NEC including, but not limited to, emergency and standby power generating systems.
- B. NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines", NFPA 110 – Standard for Emergency and Standby Power Systems
- C. UL Compliance: Comply with applicable requirements of UL 2200, "Stationary Engine Generator Assemblies" and UL 142, "Steel Aboveground Tanks for Flammable and Combustible Liquids", . Provide standby generator system components which are UL listed and labeled.

- D. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators".
- E. IEEE Compliance: Comply with applicable portions of IEEE Standard 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings", pertaining to standby power and IEEE 446, "Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications"
- F. The set shall be tested by the manufacturer of the set, as hereinafter specified. Certified test reports of the complete assembly shall be available from the engine manufacturer showing the plant's power rating, voltage and frequency regulation, and other pertinent data.

#### **1.4 SUBMITTALS**

- A. Product Data: Submit manufacturer's data on engine driven electric generator systems and components including, but not limited to, batteries, battery racks, battery charger, vibration isolation, exhaust silencer, exhaust backpressure capability, exhaust system components, control panels, fuel system components, fuel consumption rates at various loads, detailed interconnection drawings, temporary generator connection cabinet, generator enclosures (if necessary), circuit breakers, etc.
- B. Include manufacturer's standard product warranty for replacement of materials and equipment used in standby engine driven generator system.
- C. Shop Drawings: Submit dimensioned drawings of standby generators showing accurately scaled basic dimensions including auxiliary components, fuel connections and exhaust connections.
- D. Specification compliance including line by line review of each requirement in this specification. Each line shall be marked C=comply, D=deviation or NC=not compliant. Indicate justification for each item that that is not marked "C".
- E. Submit load testing reports for each generator after completion of installation.

#### **1.5 WARRANTY**

- A. The engine-generator as designated on the drawings and plans and as herein specified, shall be guaranteed to be free from original defects in both material and workmanship for a period of two years of normal use and service, except damages from other causes. This guarantee shall become effective starting the date of commissioning.

### **PART 2 - PRODUCTS**

#### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Generator Manufacturer: Subject to compliance with requirements, provide systems of one of the following:
  - 1. Caterpillar Inc.
  - 2. Cummins Inc.
  - 3. Kohler Co.
  - 4. MTU Onsite Energy
- B. Day Tank Manufacturer: Tramont TRS series or equal.

## 2.2 ENGINE GENERATOR SET

- A. Engine Driven Generator: EPA certification for Emergency Stationary use.
- B. Factory-assembled and -tested, engine-generator set.
- C. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
  - 1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- D. Capacities and Characteristics:
  - 1. Engine power shall be capable of providing full rated capacity at 104°F and altitude of 1000 feet.
  - 2. Power Output Ratings: Electrical output power rating for Standby operation of not less than as noted on the generator schedule.
  - 3. Alternator shall be capable of accepting maximum scheduled starting SkVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
  - 4. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of components. The engine-generator nameplate shall include information of the power output rating of the equipment.
- E. Generator-Set Performance:
  - 1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
  - 2. Transient Voltage Performance: Not more than 20 percent voltage drop variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
  - 3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
  - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - 5. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
  - 6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
  - 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
  - 8. Start Time: Comply with NFPA 110, Type 10 for 10 second maximum start time, system requirements.

9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

### 2.3 ENGINE

- A. Engine Features: The engine shall be heavy duty, compression ignition, water cooled, multi cylinder, 4 stroke, designed for cold quick start, capable of delivering full load output in not more than ten seconds.
- B. Rated Engine Speed: 1800RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
  1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
  2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
  3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Engine Fuel System: The engine fuel system including components shipped loose shall be installed in strict compliance to the engine manufacturer's instructions.
- E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
- F. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
- G. Cooling System: Closed loop, liquid cooled
  1. The generator set manufacturer shall provide prototype test data for the specific cooling system proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C as measured at the generator air inlet.
  2. Shall dissipate the heat through a unit mounted radiator with a fan. The fan shall be engine driven.
  3. Cooling capacity shall be not less than the cooling requirements of the engine-generator set and its lubricating oil while operating continuously at 110 percent of its specified rating.
  4. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent de-ionized water, with anticorrosion additives as recommended by engine manufacturer.
  5. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  6. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

8. The cooling system shall insure that the maximum cooling water temperature is safely within the normal working temperature range when the set is operating continuously at full load at maximum ambient temperature. when the air intake temperature of the engine room may rise to 120 deg. F. The engine outlet water temperature under such conditions shall not exceed 200 deg. F.
- H. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
- I. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
1. Provide heavy duty diesel batteries of sufficient capacity for three crank cycles of 15 second followed by 15 seconds of rest (75 seconds total).
  2. Batteries shall be sealed lead acid type certified for NFPA 110, Level 1.
  3. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
  4. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
  5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
  6. Provide battery heater with thermostatic control to regulate the output temperature to within battery manufacturer's recommended limits.
  7. Provide battery rack with vibration isolators if mounted on generator set.
- J. Battery Charger – integral to generator housing or remote mounted indoors: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
1. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
  2. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
  3. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
  4. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
  5. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
  6. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

- K. Exhaust System:
  1. The engine exhaust line shall be fitted with expansion bellows and a top outlet critical type silencer to give efficient silencing with maximum tolerable back pressure. Silencer shall be furnished with generator package.
  2. Pressure drop and back pressure in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator set while it is delivering 110 percent of its specified rating.
  3. Exhaust temperature shall not be greater than 1,399 degrees.
  4. Provide condensate trap with drain plug at low point of muffler.
  
- L. Electrical heaters, for maintaining the engines coolant temperature at the temperature recommended by the manufacturer of the engine, shall be factory installed.
  1. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for heater capacity and performance.
  2. Designed for operation on a single phase, 60Hz power connection. Heater voltage shall match circuit characteristics shown on the project drawings.
  3. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
  4. Provided with a 24VDC thermostat, installed at the engine thermostat housing
  5. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F/40C in a 60F/15C ambient, in compliance with NFPA110 Level 1 requirements

## 2.4 CONTROL AND MONITORING

- A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
  
- B. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
  
- C. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
  
- D. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
  
- E. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

- F. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
1. AC voltmeter (3-phase, line to line and line to neutral values).
  2. AC ammeter (3-phases).
  3. AC frequency meter.
  4. AC kW output (total and for each phase). Display shall indicate power flow direction.
  5. AC kVA output (total and for each phase). Display shall indicate power flow direction.
  6. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
  7. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
  8. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
  9. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
  10. DC voltmeter (alternator battery charging).
  11. Engine-coolant temperature gauge.
  12. Engine lubricating-oil pressure gauge.
  13. Running-time meter.
  14. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
  15. Fuel tank derangement alarm.
  16. Fuel tank high-level shutdown of fuel supply alarm.
  17. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, overload (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.
  18. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
  19. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
  20. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
  21. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
  22. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
- G. Remote Alarm Annunciator: Comply with NFPA 110, Level 1. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Flush mounted. Provide engine start/stop capability adjacent to annunciator panel. Provide clear hinged cover to prevent accidental operation.

- H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation. Mount at entrance to generator enclosure.
- I. Alternator Control Functions:
  - 1. The generator set shall include an automatic microprocessor-based voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from disoperation due to load induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three phase true RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The voltage regulation system shall be full wave rectified, with pulse-width modulated output design. The system shall include a torque matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. The voltage regulator shall include adjustments for gain, damping, and frequency roll off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout in the generator operator panel to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
- J. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
- K. The generator set shall be provided with a network communication module to allow real time communication with the generator set control by remote devices. The control shall communicate all engine and alternator data; alarm, shutdown and status conditions; and allow starting and stopping of the generator set via the network in both test and emergency modes.
- L. Provide a remote monitoring system for the generator set and associated equipment as shown on the drawings. The system as supplied shall include the following capabilities:
  - 1. The system as installed shall provide full site monitoring and allow an operator to view overall status, as well as detailed operating data on specific major components in the system. Operation of the system shall be secure and prevent unauthorized monitoring or control of the site equipment.
  - 2. The system shall automatically notify specific users and technicians associated with the system of alarm and status conditions on the system via email or text messages.
  - 3. No proprietary software shall be used in the system. The system shall allow monitoring through a web interface.
  - 4. The system shall monitor and record system status at rates assigned by the operator. The monitoring rates shall be configurable based on whether the system is operating or idle, awaiting a start command. On board storage data shall be provided.
  - 5. The system shall be capable of generating regularly required reports demonstrating performance, status, and history of the system.

## **2.5 GENERATOR, EXCITER, AND REGULATOR**

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.



- C. Electrical Insulation: Class H
- D. Temperature Rise: 130C
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- H. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding. Alternators operating at voltage higher than 690VAC shall be provided with form-wound stator coils.
- I. Subtransient Reactance: 12 percent maximum, based on the rating of the engine generator set.
- J. The generator shall be supplied with a thermostatically controlled strip heater to prevent the accumulation of moisture and dampness and to maintain the stator windings above the dew point. The heater shall be wired to be “on” at all times that the generator set is not operating.

## 2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
  - 1. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
  - 2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
  - 3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
  - 4. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
  - 5. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
  - 6. The protective system provided shall not include an instantaneous trip function.
- B. Generator Circuit Breakers: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
  - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous. Provide ground fault alarm only.
  - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.
5. Where multiple breakers are specified, they shall be separated in accordance with NEC Article 700.

## 2.7 FUEL STORAGE

1. Comply with NFPA 30.
2. Provide double wall day tank fuel tank sized for 4-hour run time at full load (approximately 200 gallon). Provide NEMA 3R enclosure for day tanks not mounted inside generator enclosure. Supplemental grade level bulk tank, associated pumps and piping to day tank provided by Division 22. Provide fuel fill controls, as indicated below, between day tank and bulk tank with Division 22.
  - a. Double wall construction.
  - b. UL 142 Listed.
  - c. Digital tank monitor with overfill alarm.
  - d. Leak detection.
  - e. Fill spill box.
  - f. Markings required by local codes and authority having jurisdiction.
  - g. Low and high level fuel switches
3. Fuel Transfer Pump & Day Tank: For fuel oil transfer from the day tank, an automatically controlled electric driven fuel transfer pump shall be supplied on the set. Also a suitable hand operated transfer pump shall be supplied and installed as a standby to the automatic pump; all complete with piping.
4. Fuel Fill Controls - Bulk Tank to Day Tank
  - a. Electronic Control Module (ECM) featuring a microprocessor-based fuel level control and monitoring system. The ECM supervises all performance parameters of the day tank.
  - b. The purpose of the ECM is to maintain the fuel level of the day tank by controlling the primary and secondary pumps and motors (lead/lag control). The pumps are off at the normal fuel level and is activated at 67% full. A “pump running” indicator LED is on when the pump is activated. A/B motor control relays shall control motor starters for remote pumps. Motor starters and remote pumps by Division 22.
  - c. The control system shall include electrical analog float gauge which sends a signal to the ECM for:
    - 1) Fuel level indication, pump control
    - 2) Critical High Fuel
    - 3) High fuel level warning
    - 4) Low fuel level warning
    - 5) Low fuel shut off, 6%
    - 6) Fuel in rupture basin warning
    - 7) Low fuel in remote tank warning
    - 8) ECM function signal
  - d. Fuel supply and fuel return dip tube/fittings shall allow for the connection of three engines.
  - e. Tank level sensor sends a 0-90 ohm signal to the ECM, which converts the signal into a precise fuel level. Fuel level is indicated by nine incremental LEDs on the ECM from Empty to Full.
  - f. All signals and warnings are provided with N.O. & N.C. contacts for remote annunciation. The ECM can be manually controlled by On, Off, and TEST push buttons. In addition, an internal test button allows for a periodic test of all warning LEDs and remote annunciation relays.

- g. Critical High Fuel indication shall stop primary and secondary pumps.
- h. ECM shall have 120VAC rated contacts for the control of primary and secondary fuel pump motor starters. Motor starters shall be provided by the electrical contractor. Fuel pumps shall be provided by the fuel system contractor.

## **2.8 VIBRATION ISOLATION DEVICES**

- A. Spring-type Vibration Isolators: Each generator shall be furnished with Ace Mounting Co., Inc. 812 Series, 3" deflection. Quantities determined by generator vendor for the engine-generator supplied.

## **2.9 OUTDOOR WEATHERPROOF ENCLOSURE**

- A. Enclosure shall be UL2200 listed.
- B. Construction:
  - 1. Constructed of minimum 14 ga galvanized steel or aluminum to ASTM A-446.
  - 2. Wind Rating: Wind rating shall be 150 mph minimum
  - 3. Include discharge gravity dampers, intake motorized dampers (spring operated to open & motor closed), hood with silencer.
  - 4. Louvers: Equipped with galvanized bird screen to permit air circulation when engine is not running while excluding birds and rodents.
  - 5. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
  - 6. Extend coolant and oil drains with shut off valves.
  - 7. Hardware: All hardware and hinges shall be stainless steel.
  - 8. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
  - 9. Provide 2 coats of primer and 2 coats of finish paint.
- C. Exhaust System: Provide critical type silencer mounted within enclosure.
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load. Refer to the generator schedule for maximum log average sound pressure level measured positions around the perimeter of the unit at a distance of 23 ft.
- E. Electrical provision:
  - 1. Package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing.
  - 2. External Electrical Connections: All power and control interconnections shall be made within the perimeter of the enclosure.
  - 3. Provide 100 amp 120/240V single phase load center. All generator accessories and connections shall be pre-wired to the load center.
  - 4. Provide DC lighting with 60-minute spring round timer switch and fused connection to the engine-starting batteries.
  - 5. Provide internal AC lighting, switches, internal GFCI service receptacle, and external GFCI service receptacle.
  - 6. Provide externally mounted emergency stop switch.

- F. Provide enclosure insulation and unit heater to maintain enclosure temperature to minimum 40 degrees F when generator is not operating and serves Emergency/Life Safety loads per NFPA 110, Level 1. Heater shall be disabled while the engine is running.

## **2.10 SOURCE QUALITY CONTROL**

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

## **2.11 TEMPORARY GENERATOR MAINTENANCE CABINET**

- A. Manufacturer Temporary Generator Maintenance Cabinet: Subject to compliance with requirements, provide products of one of the following:
  - 1. ESL Power Systems
  - 2. HIPOWER
  - 3. Lex Products
  - 4. Power Products Inc.
  - 5. Powertron
  - 6. Trystar
- B. General: Except as otherwise indicated, provide a manual transfer cabinet with temporary generator connections and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installer's option.
- C. The temporary generator maintenance cabinet shall be equipped as follows:
  - 1. Basis-of-design: ESL Power Systems Stormswitch.
  - 2. Voltage: As noted on drawings
  - 3. Manual transfer switch shall consist of (2) two mechanically-interlocked molded case circuit breakers, cam-style male connectors, power distribution block and grounding terminals, all housed within a padlockable enclosure.
  - 4. Manual transfer switch enclosure shall be Type 3R, constructed of continuous welded, powder coated steel or aluminum. The main access shall be through an interlocked, hinged door. Access to cam-style plugs shall be via hinged or drawn flange cable entry openings in the bottom of enclosure. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened. Enclosure shall be powder coated after fabrication.
  - 5. Cam connectors shall not be accessible unless all molded case circuit breakers are in the "OFF" position and the main access door is open.

6. Temporary generator cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Camstyle male connectors shall be provided for each phase and for ground, and neutral. Each of the phase cam-style male connectors within the enclosure shall be factory-wired to a molded case circuit breaker or switch. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor.
7. Provide multiple sets of connectors when switch capacity of over 400A is specified.
8. Breakers: 100% rated molded case, 4-pole. The permanent generator circuit breaker shall be a molded case switch with no overcurrent protection.
9. Switch shall include a switch position contact to be interconnected with the generator controller & generator annunciator. Disconnecting the permanent generator shall initiate visual notification at the generator control panel and remote annunciator.
10. Listing: UL 1008. Shall meet requirements of NEC 700.3.
11. Where 4-pole circuit breakers are used, provide placard on cabinet exterior "BOND NEUTRAL TO GROUND AT ROLL-UP GENERATOR".

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION OF ENGINE GENERATOR SYSTEMS**

- A. Install engine generator sets as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine generator sets fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of standby engine generator systems and accessories.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Prior to starting the engine-generator, the manufacturer's representative shall review the installation to ensure it is installed in accordance with the manufacturer's instruction. This includes, but is not limited to, exhaust connections, fuel piping, and ventilation clearances. Any irregularities or concerns shall be submitted to the engineer in writing.
- D. Coordinate with other work, including fuel tanks, piping and accessories, as necessary to interface installation of standby generator system work with other work.
- E. All service connections, fuel, water, electric, etc. to the engine shall be through flexible connection devices. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- F. Environmental air permitting shall be completed by the Owner. Provide all required information for the installation and operation permitting process. Where witness testing is required, contractor shall operate engine-generator for test.

### **3.2 INTERFACE AND COORDINATION WITH AUXILIARY SYSTEMS**

- A. Fuel piping.
  - 1. The engine-generator authorized vendor shall examine the drawings to verify supply and return fuel piping meet the manufacture's requirements for size, length and elevation changes prior to generator installation. In the event changes are required, the Engineer shall be notified in writing.
  - 2. Provide all control wiring from fuel fill controls to pumps by Division 22. All wiring shall be in conduit and follow fuel pipe routing.

### **3.3 INSTALLATION OF TEMPORARY GENERATOR CONNECTION AND MANUAL TRANSFER CABINET**

- A. Install transfer switch as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Provide monitoring wiring from auxiliary position contact to the generator/generator annunciator. Generator annunciator shall indicate when the permanent generator is disconnected.
- C. Coordinate with other work including generator and electrical wiring/cablng work, as necessary to interface installation of transfer switch.

### **3.4 GROUNDING**

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground, for system components as indicated
- B. Where engine-generator is a separately derived source, bond to facility grounding electrode conductor.

### **3.5 TESTING**

- A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:
  - 1. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
  - 2. Installation acceptance tests to be conducted on site shall include a "cold start" test, a 2-hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110.
  - 3. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.
- B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

- C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a 2-hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110.
- D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.
- E. Test temporary generator and connection cabinet including connecting a temporary generator and transferring power.

**3.6 TRAINING**

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration. Training date shall be coordinated with the facility owner.

**3.7 SYSTEM SERVICE CONTRACT**

- A. The supplier of the standby power system must provide a copy of and make available to the owner their standard service contract which, at the owner's option, may be accepted or refused. This contract shall be included in the operation and maintenance manual supplied at the end of the project. The contract shall be for the complete services rendered over a period of one year.

**END OF SECTION 26 32 13**

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## SECTION 26 33 23 - CENTRAL BATTERY EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Contractor shall furnish, install and place in operation the emergency light and power system work as indicated by drawings and schedules.
- B. Refer to other Division 26 sections for wires/cables raceways, and electrical boxes and fittings work required in connection with emergency light and power systems.
- C. Refer to another Division 26 section for engine generator units required in connection with emergency light and power systems.

#### 1.3 QUALITY ASSURANCE

- A. NEC compliance: Comply with NEC as applicable to wiring methods, materials, construction and installation of emergency light and power systems.
- B. UL Compliance: Comply with applicable requirements of UL 924, "Emergency Lighting and Power Equipment". Provide ELP system components which are UL listed and labeled.
- C. ANSI/NEMA Compliance: Comply with ANSI/NEMA Std. Pub. No. ICS 2, pertaining to AC automatic transfer switches.
- D. IEEE Compliance: Comply with applicable requirements of IEEE standards pertaining to semiconductor rectifier components.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on emergency light and power systems and components.
- B. Shop Drawings: Submit dimensioned drawings of emergency light and power systems and accessories including, but not necessarily limited to rectifiers, inverters, static transfer switches, maintenance switches, batteries, and instruments. Show accurately scaled layouts of emergency light and power system equipment and their spatial relationship to associated equipment; show connections to normal and standby electrical power feeders.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
  - 1. Evenlite

2. Crucial Power Products/Perfect Power Systems
3. Philips Chloride
4. Dual Lite
5. IOTA Engineering
6. Myers Power Products
7. LightAlarms

## **2.2 EMERGENCY LIGHTING POWER SYSTEMS, 2.1kW to 17kW**

- A. Basis of Design: Crucial Power Products Wave Rider I
- B. General: The Emergency Lighting Power System shall be a solid-state single phase unit designed to provide regulated and conditioned sinusoidal power for emergency lighting applications. The Emergency Lighting Power System shall provide uninterrupted power during all modes of operation. There shall be no interruption of power to the lighting system when the unit transfers to and from battery operation. The Emergency Lighting Power System and battery subsystem shall be listed to UL 924 Standard for Emergency Lighting and Power Equipment by a nationally recognized organization.
- C. Capacity: As indicated on the drawings. The Emergency Lighting Power System shall be able to operate at the specified capacity regardless of the type of lighting load including LED.
- D. Input/Output Voltage: 208:208 volt as indicated on the drawings.
- E. Circuit Breakers: Provide input, output and DC circuit breakers.
- F. Batteries: Sealed, maintenance-free batteries shall be provided. The batteries shall have an expected life of ten (10) years. The batteries shall be fully wired and contained within a battery section. Battery run time (based on 100% full load) shall be no less than ninety (90) minutes
- G. Monitoring Panel: Front panel display indicating system status. The unit display shall indicate the following:
  1. Indicating Lights.
    - a. Lighting Power System On. Power is present at the input and the system has been turned on.
    - b. Output Available. Indicating system is providing power to the system output.
    - c. Battery Mode. Indicating system is operating in battery mode.
    - d. Fault. Visual and audible indication of a system fault.
  2. LCD display indicating system status, input/output voltage, battery voltage, battery capacity remaining, output load, temperature and event history.
- H. Provide NEMA 1 floor mounted enclosure.
- I. Surge Protection: ANSI/IEEE C62.45 category A and B.
- J. Testing and Self-diagnostics: Continuous self-diagnostics, battery exerciser and self-testing.
- K. Refer to the drawings for the quantity of normally on and normally off circuit breakers.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF EMERGENCY LIGHT AND POWER SYSTEMS**

- A. Install emergency light and power systems as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that ELP system equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA'S "Standard of Installation" pertaining to general electrical installation practices.
- B. Coordinate with other electrical work, including cables/wires, raceways, electrical boxes and fittings, as appropriate to interface installation of emergency light and power systems work with other work.
- C. Install floor mounted units on a concrete housekeeping pad. Pad to be 4 inches high, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of equipment unless otherwise indicated.

### **3.2 GROUNDING**

- A. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground, for emergency light and power system equipment as indicated.

### **3.3 LOAD WIRING**

- A. All branch circuits connected to the output circuit breakers are considered an emergency power supply system (EPSS) and shall be installed in a separate conduit system.

### **3.4 FIELD QUALITY CONTROL**

- A. Upon completion of installation of emergency lighting power system equipment, and after building circuitry has been energized with normal power source, test ELP system to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

### **3.5 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that central battery inverter is installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
- D. Complete installation and startup checks according to manufacturer's written instructions.

### **3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters.

**END OF SECTION 26 33 23**

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## SECTION 26 36 00 - TRANSFER SWITCHES

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.
- B. Section 26 32 13 – Engine Generators.

#### 1.2 DESCRIPTION OF WORK

- A. Provide automatic transfer switches as indicated on drawings and schedules.

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of transfer switches.
- B. UL Compliance and Labeling: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches".
- C. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to automatic transfer switches and enclosures.
- D. Automatic transfer switches shall be sourced from a single manufacturer.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on transfer switches.
- B. Shop Drawings: Submit dimensioned drawings of transfer switches showing accurately scaled equipment layouts and spatial relationship to associated equipment.
  - 1. Include electrical ratings, dimensions, mounting, material, branch circuit overcurrent protection, wiring diagrams, interlocking, and accessories.

#### 1.5 WARRANTY

- A. The transfer switches as designated on the drawings and plans and as herein specified, shall be guaranteed to be free from original defects in both material and professionalism for a period of two years of normal use and service, excepting damages from other causes. This guarantee shall become effective starting the date of substantial completion.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer Automatic Transfer Switches: Subject to compliance with requirements, provide products of one of the following:
  - 1. ASCO Power Technologies/Schneider Electric
  - 2. Russelectric/Siemens

3. ABB/GE Industrial Solutions/Zenith
4. Caterpillar
5. Cummins
6. Kohler

## 2.2 AUTOMATIC TRANSFER SWITCHES

- A. General: Except as otherwise indicated, provide transfer switches and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installer's option.
- B. Automatic Transfer Switches shall be equipped as follows:
  1. The switch shall be rated for the voltage and amperage as shown on the plans and shall have 600 volt insulation on all parts in accordance with NEMA standards.
  2. Switch(es) shall have withstand rating that is greater or equal to withstand ratings of upstream breakers.
  3. Switch(es) shall have transition type as shown on drawings.
  4. For closed transition switch(es), provide shunt trip signal and interlock to upstream emergency breakers to trip upon fail to transfer condition.
  5. The current rating shall be a 24 hour continuous rating when the switch is enclosed in an unventilated enclosure, and shall conform to NEMA temperature rise standards.
  6. The thermal capacity of the main contacts shall not be less than 20 times the continuous duty rating for a minimum of 3 electrical cycles as established by certified test data.
  7. Temperature rise test shall be in accordance with UL 1008 except that it shall be conducted at the conclusion of the overload and endurance tests.
  8. The automatic transfer switch shall be a double throw switch operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer in 3 cycles or less.
  9. The normal and emergency contacts shall be mechanically interlocked such that failure of any coil or disarrangement of any part shall not permit a neutral position.
  10. For switches installed in systems having ground fault protective devices, a 4th pole shall be provided. This additional pole shall isolate the normal and emergency neutrals. The neutral pole shall have the same withstand and operational ratings as the other poles and shall be arranged to break last and make first to minimize neutral switching transients.
  11. The contact structure shall consist of a main current carrying contact which is a silver alloy with a minimum of 50% silver content. The main current carrying contacts shall be protected by refractory arcing contacts on all sizes.
  12. All relays shall be continuous duty industrial type with wiping contacts rated at 10 amperes minimum.
  13. All coils, relays, timers and accessories shall be readily front accessible.
  14. Main and arcing contacts shall be fully visible without major disassembly to facilitate inspection and maintenance.
  15. A manual handle shall be provided for maintenance purposes.
  16. A disconnect switch shall be provided to defeat automatic operation during maintenance, inspection or manual operation.
  17. The switch shall be mounted in a suitable NEMA enclosure to meet application requirements as indicated on the plans.
  18. Sensing Relays shall be provided as follows:
    - a. Provide voltage sensing relays in each phase of the auxiliary power supply.
    - b. Provide a voltage frequency sensing relay in one phase of the auxiliary power supply.

19. The following accessories shall be included with the transfer switch:
  - a. Indicating lights:
    - 1) Provide a signal light for normal source position.
    - 2) Provide a signal light for emergency source position.
    - 3) Lights shall be different colors.
    - 4) Provide laminated black phenolic nameplates with white letters to indicate transfer switch position.
  - b. Manual Test Switch: Shall simulate normal source failure.
  - c. Engine starting contacts.
  - d. Time Delay Relays:
    - 1) Provide time-delay relays to accomplish the functions hereinafter specified.
  - e. Auxiliary Contacts:
    - 1) Provide contacts as necessary to accomplish the functions shown on the drawings, hereinafter specified, and designated in other sections of these specifications.
    - 2) Contacts shall have a minimum rating of ten amperes and be positive acting on pickup and dropout.
  - f. Provisions for Remote Indicators and Controls:
    - 1) Provisions shall be made for remote pilot lamps to show transfer position.
    - 2) Make provisions for remote manual test switch to simulate normal source failure.
    - 3) Make provisions for remote contact to bypass retransfer time delay to normal source.
  
- C. Provide Bypass/Isolation Switch to allow direct connection of load to the normal or emergency power source for maintenance.
  1. The isolating portion of the bypass/isolation shall allow the ATS to be disconnected from all sources of power and control without opening the enclosure door. The transfer switch shall have a true draw-out configuration that does not require disconnection of any electrical or mechanical device by maintaining personnel. The ATS shall be provided with rollers or casters to allow it to be removed from the enclosure simply by rolling it out. The automatic transfer and bypass/isolation switch shall have three modes of operation.
    - a. Automatic, the ATS connected and in automatic operating mode.
    - b. Test, the ATS disconnected from the main bus but controls connected allowing testing of the ATS without impact on the load.
    - c. Isolation, the ATS is completely disconnected for the bypass/isolation switch and free to be removed from the enclosure.
  2. Bypass switch shall be open transition with only fully opened or fully closed position with no middle position.
  
- D. Elevator Interface
  1. Provide contacts to indicate emergency power status to elevator controller and indicate pre-transfer back to normal signal. Pre-transfer signal shall be initiated prior to transfer of switch from emergency to normal and vice versa.
  
- E. Generator Remote Start Control Wire Monitoring
  1. Provide audible and visual notification of generator remote start circuit integrity at generator control panel and remote annunciator. Fault shall automatically start generator. Install at generator and each automatic transfer switch.
  2. Basis of design: ASCO 5101 engine start and ATS modules.

## **2.3 SYSTEM OPERATION**

- A. A voltage decrease in one or more phases of the normal power source to less than 70 percent of normal shall initiate the transfer sequence. The transfer switch shall start the engine-generator unit after a time-delay of two or three seconds to permit override of momentary dips in the normal power source. The time-delay shall be field adjustable.
- B. The transfer switch shall transfer the load from normal to emergency source when the frequency and voltage of the engine-generator unit have attained 90 percent of rated value.
- C. The transfer switch shall retransfer the load from emergency to normal source upon restoration of normal supply in all phases to 90 percent or more of normal voltage an after a time-delay. The time-delay shall be field adjustable from five to twenty-five minutes (preset for twenty-five minutes). Should the emergency source fail during the timing, the transfer switch shall immediately transfer to normal when the source is available.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF AUTOMATIC TRANSFER SWITCHES**

- A. Install automatic transfer switches as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate with other work including generator and electrical wiring/cabling work, as necessary to interface installation of automatic transfer switch.
- C. Provide pre-transfer signal wiring from ATS to elevator controller. Final termination at elevator controller by Elevator Contractor.
- D. Parallel engine start signal wiring between ATS' so that any normal power failure at any transfer switch will start the generator.
- E. Engine start circuits shall be kept entirely independent of all other wiring.

### **3.2 ADJUST AND CLEAN**

- A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.

### **3.3 TESTS AND CERTIFICATIONS**

- A. The automatic transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation to operate between a normal and emergency source that are 120 degrees out of phase at 480 volts for the following load currents and power factors:
  - 600% of nominal at .50 power factor
  - 20% of nominal at .50 power factor



- B. The automatic transfer switch manufacturer shall submit test data for each size switch, showing it can withstand, without damage, fault currents of the magnitude and the duration necessary to maintain the system integrity.
- C. Upon completion of automatic transfer switches, test units with associated system components to demonstrate capability and compliance with requirements.

**END OF SECTION 26 36 00**

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**SECTION 26 43 13 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL  
POWER CIRCUITS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.
- B. Section Includes: Surge Protective Devices (SPD) for Service Entrance and Branch Panel applications.

**1.2 REFERENCES**

- A. ANSI/IEEE C.62.41 and C62.45
- B. UL 1449 – 4th Edition
- C. UL 1283
- D. NEC – NFPA 70
- E. NEMA LS1
- F. NFPA
- G. OSHA
- H. IEEE Std. 1100

**1.3 SUBMITTALS**

- A. Shop Drawings: Provide Shop Drawings with wiring diagrams, installation information, testing and maintenance procedures, and operational information for the transient protection system. Shop Drawings shall be submitted to Design Professional for approval before starting actual fabrication.
- B. Submittals for Approval: Provide the following test data submittals:
  - 1. Manufacturer will provide UL-1449, Fourth Edition data card showing the Voltage Protection Rating (VPR) and “Engineering Considerations” for the specific catalog number submitted. “Typical” UL 1449 data is not acceptable. Test data shall be provided to demonstrate the short circuit current rating has been tested on a complete device.

**PART 2 - EQUIPMENT**

**2.1 SERVICE ENTRANCE SPD**

- A. Environmental
  - 1. General Requirements:
    - a. No audible noise shall be generated.

- b. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
- c. Operating Conditions:
  - 1) 30 – 130 Degrees F
  - 2) 15 – 85 Percent Humidity Non-Condensing
- d. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure unless specified otherwise.
- e. Units mounted at service entrance equipment shall be Type 1 and 20kA I-nominal rated.

B. General Requirements

- 1. SPD shall be rated to match equipment voltage, 60 Hertz, 3-phase, 4-wire system and shall be connected in parallel with the main switchboard.
- 2. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.
- 3. Unit shall be UL 1449, 4th Edition Listed. A SPD that is a UL “Recognized” component will not be accepted.
- 4. Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC.
- 5. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.
- 6. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

C. Manufacturers and Specific Product Requirements

- 1. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows:
  - a. ASCO Power Technologies
  - b. ABB / Current Technology
  - c. Raycap
  - d. Mersen
  - e. Transdector/LEA
  - f. Schneider Electric/Square D
  - g. Siemens
  - h. Eaton
- 2. Unit shall provide maximum Voltage Protection Rating as indicated by UL 1449.
- 3. The SPD will be modular in design. Separate and replaceable suppression modules will protect each mode (L-N, L-G, and N-G).
- 4. The service entrance SPD will be capable of surviving 15,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%
- 5. Unit shall have a maximum surge current rating of 125kA per mode (125,000 amperes L-N, 125,000 amperes L-G, and 125,000 amperes N-G), based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.
- 6. Unit shall be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 MHz.
- 7. Unit shall include a built-in, push-to-test feature that tests the integrity of all modules, MOVs and fuses in the system

8. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years from date of installation. Warranty shall cover unlimited replacement of system protection modules during warranty period. The first 5 years of this warranty will include any field labor required to perform repair or replacement work.

## 2.2 BRANCH PANEL SPD

### A. Environments

1. General Requirements:
  - a. No audible noise shall be generated.
  - b. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
  - c. Operating Conditions:
    - 1) 30 – 130 Degrees F
    - 2) 15 – 85 Percent Humidity Non-Condensing
2. Enclosure: The unit shall have a heavy duty NEMA 12 dust-tight, drip-tight enclosure.

### B. General Requirements

1. Branch Panel Equipment (where indicated on drawings): Rated to match equipment voltage, 60 Hertz, 3-phase, 4-wire distribution board or panelboard.
2. Quality: The manufacturer shall be ISO 9001 certified, demonstrating world-class quality systems for the design and manufacture of the SPD units.
3. Unit shall be UL 1449 4th Edition Listed. A SPD that is a UL “Recognized” component will not be accepted.
4. Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC.
5. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.
6. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

### C. Manufacturers and Product Requirements

1. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows:
  - a. ASCO Power Technologies
  - b. ABB - Current Technology
  - c. Raycap
  - d. Mersen
  - e. Transdector/LEA
  - f. Schneider Electric/Square D
  - g. Siemens
  - h. Eaton
  - i. Internally mounted SPD manufactured and provided by the manufacturer of the gear in which it is mounted
2. Unit shall provide maximum Voltage Protection Rating (VPR) as indicated by UL 1449.
3. The branch panel SPD will be capable of surviving 10,000 ANSI/IEEE, Category C3 (10kA) impulses without failure or degradation of original performance characteristics of more than 10%

4. Unit shall have a maximum surge current rating of 80kA per mode (80,000 amperes L-N, 80,000 amperes L-G, and 80,000 amperes N-G), based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.
5. Unit shall be UL 1283 listed as an electromagnetic interference filter and provide 50 Ohm noise attenuation of at least 40 dB at 100 kHz, 30 dB at 1 MHz, 35 dB at 10 MHz, and 50 dB at 100 MHz.
6. Warranty: Manufacturer shall provide a product warranty for a period of not less than 5 years from date of installation.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

##### **A. General Requirements:**

1. Contractor shall install suppression system immediately next to or on top of service equipment where so approved by the Design Professional.
2. Conductors between suppressor and point of attachment to service equipment shall be sized in accordance with manufacturer's Shop Drawings and conductor lengths shall be as short as possible, preferably not exceeding 24".
3. Use SPD low-impedance cable listed for the application to enhance clamping voltage where unit is not mounted on or within equipment that it's protecting.

##### **B. Grounding: Suppressor ground shall be bonded to the equipment grounding busbar.**

**END OF SECTION 26 43 13**

## SECTION 26 50 00 - LIGHTING

### PART 1 - GENERAL

#### 1.1 RELATED WORK

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 26 05 00 – Common Work Results for Electrical are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. Provide lighting fixtures, accessories, labor and supervision necessary to install complete lighting system as required by the drawings and this section.
- B. Types of lighting fixtures in this section include the following:
  - 1. Solid State (LED)
  - 2. Exit Signs
  - 3. Emergency
  - 4. Exterior Luminaires

#### 1.3 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to installation and construction in building lighting fixtures.
- B. NEMA Compliance: Comply with applicable requirements of NEMA standard publications pertaining to lighting equipment.
- C. Listings: Provide lighting fixtures which have been listed and labeled. Listing or labeling shall be by UL, ETL Intertek or other nationally recognized agency.
- D. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

#### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on interior and exterior lighting fixtures.
- B. Shop Drawings: Submit fixture shop drawings in pdf form with separate sheet(s) for each fixture type arranged in alphabetical order. Include proposed options and accessories clearly indicated on each sheet.
  - 1. Submittal shall indicate the specific lumen output and power consumption for each fixture type.
  - 2. For fixtures requiring field assembly provide factory generated shop drawings indicating feed points, joint locations, and assembly instructions.
  - 3. Include driver product data for each fixture type.
  - 4. The pdf shall be book-marked by the fixture type. Submittal that are not bookmarked will be returned without review.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Manufacturers shall be as listed in the light fixture schedule on the drawings.
- B. Basis of Design Product: The design for each luminaire is based on the product named and described in the light fixture schedule on the drawings. Provide either the named product or a comparable product by one of the equivalent manufacturers listed. Equivalent manufacturers shall match the basis of design product in both form and function. The Architect and Engineer have the final acceptance of equivalent products. Where equivalent products are not determined to match the basis of design, the basis of design product shall be provided at no additional cost to the Owner. Upon request, equivalent manufacturers shall submit lighting calculations and ies files to prove performance of product and samples for table top viewing.

### **2.2 SOLID STATE LIGHTING / LIGHT EMITTING DIODE (LED) LUMINAIRES (Greater than 20W)**

- A. General:
  - 1. Luminaire manufacturer shall have a minimum of five (5) years' experience in the manufacture and design of LED products and systems.
  - 2. All LED sources used in the LED luminaire shall be of proven quality from established and reputable LED manufacturers. Acceptable LED lamp manufacturers unless otherwise noted are:
    - a. Cree, Inc.
    - b. Philips Lighting
    - c. Nichia Corporation
    - d. Norlux
    - e. Opto Technology, Inc.
    - f. Osram Optronic Semiconductors
    - g. Samsung
- B. LED Warranty
  - 1. Luminaire manufacturer provide a five (5) year written warranty.
- C. Replacement and Spares:
  - 1. Manufacturer shall provide written guarantee of the following:
    - a. Manufacturer shall be able to provide compatible replacement parts that are designed to fit into original luminaire for ten (10) years.
    - b. Replacement LED array/module shall be within 3 MacAdam color ellipse, within 10% of lumen output, 7% of correlated color temperature (CCT) and equivalent distribution of original array/module.
    - c. Replacement LED array/module shall utilize equal to or less than amount of wattage of original array/module.
  - 2. LED driver and array/module shall be replaceable in field.
- D. Products and Components – Performance:
  - 1. All LED components shall be mercury-free and lead-free.



2. LEDs shall comply with ANSI/NEMA/ANSLG C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products. Color shall remain stable throughout the life of the light source.
3. LEDs shall comply with IESNA LM-80 – Standards for Lumen Maintenance of LED Lighting Products.
4. LEDs shall have a minimum rated source life of 50,000 hours under normal operating conditions or as noted on the lighting fixture schedule. LED “rated source life” is defined as the time when a minimum of 70% of initial lumen output remains, as defined by IESNA LM-70.
5. Luminaire assembly shall include a method of dissipating heat so as to not degrade life of source, electronic equipment, or lenses. LED luminaire housing shall be designed to transfer heat from the LED board to the outside environment. Luminaire housing shall have no negative impact on life of components. Upon request, manufacturer shall provide junction temperature limitations and test reports of installed LED in fixture.
6. Method of dissipating heat shall be passive, active cooling systems are not allowed.
7. High power LED luminaires shall be thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware.
8. LEDs shall be adequately protected from moisture or dust in interior applications.
9. For wet and damp use, LED-based luminaires itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure. Such protection shall have no negative impact on rated life of source or components, or if so, such reductions shall be explicitly brought to the attention of the designer.
10. All hardwired connections to LED luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
11. Manufacturer shall provide Luminaire Efficacy (lm/W), total luminous flux (lumens), luminous intensity (candelas) chromaticity coordinates, CCT and CRI. Optical performance, polar diagrams, and relevant luminance and illuminance photometric data. Provide data in IES file format in accordance with IES LM-79-2008, based on test results from an independent Nationally Recognized Testing Laboratory. Provide information upon special request.

E. LED drivers shall meet the following requirements:

1. Drivers shall have a minimum efficiency of 85%.
2. Minimum/Maximum Ambient Temperature: -20°C/55°C interior locations, -40°C/55°C exterior locations,
3. Input Voltage: 120 to 277 (±10%) V or as scheduled.
4. Power Supplies: Class I or II output.
5. Dimming Type: 0-10V control with current source driver, current sinking drivers are not allowed.
6. Surge Protection for exterior fixtures: The system must survive 250 repetitive strikes of “C Low” (C Low: 6kV/1.2 x 50 μs, 10kA/8 x 20 μs) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. “C Low” waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
7. Power Factor (PF): ≥ 0.90.
8. Total Harmonic Distortion (THD): ≤ 20%.
9. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
10. Drivers shall be reduction of hazardous substances (ROHS)-compliant.
11. Mean Time Between Failure (MTBF): 100,000 hours based on 90% survival.

## 2.3 EXIT SIGNS

- A. Housing to be per light fixture schedule (thermoplastic, edge lit or cast aluminum) for wall, end or ceiling mounting. Illumination to be by long life, low watt LED lamps. Battery, where specified, to be maintenance free, sealed nickel-cadmium type and shall operate sign for 90 minutes after loss of power.

## 2.4 EMERGENCY FIXTURES

- A. Housing and lamping per light fixture schedule. Self contained complying with UL 924. Battery to be premium grade, lead-acid or nickel cadmium, maintenance free battery and shall operate sign for 90 minutes after loss of power.

## 2.5 EXTERIOR LUMINAIRES

### A. General:

1. Poles shall be as shown on the drawings, and as specified. The pole and arm assembly shall be designed for wind loading of 100 mph with an additional 30% gust factor, supporting luminaire(s) and accessories such as shields, banner arms, and banners.
2. Poles shall have handhole having a minimum clear opening of 2.5 x 5 in. Handhole covers shall be secured by stainless steel captive screws.
3. Provide a steel-grounding stud opposite handhole openings, designed to prevent electrolysis when used with copper wire.
4. Provide a base cover that matches the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts. Plastic base covers are not allowed.
5. Hardware and Accessories: All necessary hardware and specified accessories shall be the product of the pole manufacturer.
6. Provide manufacturer's standard finish and color, as scheduled on the drawings. Provide custom finishes only where specifically indicated on the drawings.

### B. Pole Types:

1. Aluminum: Provide aluminum poles manufactured of corrosion-resistant AA AAH35.1 aluminum alloys conforming to AASHTO LTS-4. Poles shall be seamless extruded or spun seamless type. Poles 12' or greater in height shall be provided with an internal, factory installed, vibration damper.
2. Steel: Provide steel poles having minimum 11-gauge steel with minimum yield/strength of 48,000 psi. Poles 12' or greater in height shall be provided with an internal, factory installed, vibration damper.
3. Prestressed Concrete: Provide prestressed concrete, raceway-type, lighting poles of the size and type indicated. Provide luminaire brackets as required for complete assemblies.

### C. Foundations for Poles:

1. Foundations shall be cast-in-place concrete, having 3000 psi minimum 28-day compressive strength.
2. Place concrete in spirally-wrapped treated paper forms for round foundations, and construct forms for square foundations.
3. Rub-finish and round all above-grade concrete edges to approximately 0.25 in radius.
4. Anchor bolt assemblies and reinforcing of concrete foundations shall be as shown on the drawings. Anchor bolts shall be in a welded cage or properly positioned by the tie wire to stirrups.
5. Prior to concrete pour, install ground electrode.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF INTERIOR LIGHTING FIXTURES**

- A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of the National Electric Code (NEC), NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. All low-voltage luminaires using remote drivers or power supplies shall be installed as follows:
  - 1. Installation shall be in compliance with the manufacturer's instructions including distance limitations.
  - 2. Remote drivers and power supplies shall be located in accessible locations and clearly noted on as-built plans. Where plywood is used for power supply mounting, plywood shall be UL Listed fire resistant.
  - 3. Unless specifically noted "Class 2", all low-voltage wiring between remote drivers or power supplies and luminaires shall be considered Class 1 and installed in accordance with NEC Article 725. Wiring shall be 600V rated and installed in conduit.
  - 4. All remote drivers and power supplies not specifically labeled "Class 2" on the power supply housing shall be installed in a ventilated metal enclosure. Where the power supply includes cooling fan or convection cooling, ventilation openings in enclosure shall be provided to not impede power supply cooling.
- C. Coordinate with other electrical work as appropriate to properly interface installation of interior lighting fixtures with other work.
- D. Coordinate fixture location with reflected ceiling plan.
- E. Recessed fixtures in removable ceilings shall be connected to the branch circuit with flexible conduit and branch circuit wire from an accessible junction box. Where fluorescent fixture housings are connected together, use 90 deg.C wire for branch circuit feed through fixture channels.
- F. All fixtures shall be grounded. All lamp sockets shall be wired so that the outer shell is connected to the neutral grounded conductor.
- G. Fixtures recessed in furred ceiling shall be installed so that they can be removed from below the ceiling.
- H. Luminaires located in suspended ceilings shall be connected with a maximum 6 foot length of flexible metal conduit and building wire.
- I. Housing, trim, and lens frame shall be true, straight and parallel to each adjacent fixtures and features.
- J. Contractor shall include all materials and labor necessary for the final aiming and adjusting of adjustable light fixtures. Adjustment of light fixtures may be required to occur after sunset at a time designated by the Engineer.
- K. Round fixtures or fixtures smaller than the ceiling grid shall have at least two (2) 3/4 inch (19 mm) metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture.

- L. Troffer, recessed and semi-recessed fixtures shall be installed at a minimum per the manufacturer's instructions and the requirements below. Fixtures shall not be supported directly on the ceiling material. Support fixtures with metal bar hangers or strut channels attached to the ceiling tees. Coordinate with Ceiling Contractor to ensure ceiling tees can support the weight of the light fixtures.
- M. Suspended Linear or Pendant mounted fixtures shall be independently supported from the building structure by wires, straps or rods.
- N. Fixture whips shall be in accordance with section 26 05 33 Raceway and Boxes for Electrical Systems.

### **3.2 INSTALLATION OF EXTERIOR LIGHTING FIXTURES**

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole. Install poles plumb and level.
- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.
- C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
- D. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on drawings, but not less than one-sixth of pole height. Dig holes large enough to permit use of tampers in the full depth of hole. Backfill in 6 inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- E. Coordinate locations and elevations of base mounted site fixtures with site plans, do not scale electrical drawings for placement of light poles.

**END OF SECTION 26 50 00**

**DIVISION 27**



## SECTION 27 00 10 - COMMUNICATIONS GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section applies to all work under the telecommunications contract. This shall include, but not necessarily be limited to, the following:
  - 1. Pre-Register Project with structured cabling plant manufacturer if applicable.
  - 2. Furnish and install a complete voice and data-wiring infrastructure.
  - 3. Furnish, install, and terminate all UTP cable and fiber as applicable and per drawings.
  - 4. Furnish and install all wall plates, jacks, patch panels, and patch cords as required and as indicated.
  - 5. Furnish and install any cabinets, racks and ladder rack as required and as indicated.
  - 6. Furnish any other material required to form a complete system.
  - 7. Perform permanent link testing (100% of links) and certification of all components.
  - 8. Furnish test results of all cabling to the owner on disk and paper format, listed by each closet, then by workstation ID.
  - 9. Provide Owner As-builts in the form of one electronic copy and two hard copies of a labeled map of the building(s) showing the structured cabling plant.
  - 10. Adhere and comply with all requirements of the Contractor Agreement for the structured cabling plant manufacturer to be used.
  - 11. Provide Owner training and testing documentation.
- B. The work shall include all materials, equipment and labor required for complete and properly functioning telecommunications systems.
- C. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
- D. All work shall be performed in a neat, professional manner in keeping with the highest standards of the craft.

#### 1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
  - 1. National Electrical Code
  - 2. Local Electrical Code
  - 3. National Fire Protection Association
  - 4. National Electrical Manufacturers Association
  - 5. Standards of Institute of Electrical and Electronic Engineers
  - 6. Applicable Building Codes
  - 7. Occupational Safety and Health Act
  - 8. Wisconsin Administrative Codes
  - 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant

10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
  11. ANSI TIA-568-D.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
  12. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
  13. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
  14. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
  15. ANSI TIA-569-D Telecommunications Pathways and Spaces
  16. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
  17. ANSI TIA-598-D Optical Fiber Cable Color Coding
  18. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
  19. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  20. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
  21. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)
- B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of professionalism shall take precedence, but such questions shall be referred to Design Professional for final decision.

#### **1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES**

- A. Contractor shall comply with the rules and regulations of the local serving utility companies and shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.
- B. Secure and pay for all permits, licenses, fees and inspections.

#### **1.5 DRAWINGS**

- A. Drawings for the work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.
- B. Contractor shall layout their own work and shall be responsible for determining the exact quantities and locations for equipment.
- C. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.
- D. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code (or referenced standards) where they are required for proper installation and operation of the work, such items shall be furnished and installed.

#### **1.6 ACTIVE SERVICES**

- A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.



- B. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.
- C. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

#### **1.7 SITE INSPECTION**

- A. Contractor shall inspect the site prior to submitting bid for work to become familiar with the conditions of the site which will affect the work and shall verify points of connection with utilities and/or existing system wiring.
- B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.

#### **1.8 COORDINATION AND COOPERATION**

- A. It shall be Contractor's responsibility to schedule and coordinate work with the schedule of General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of their work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to their equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Drawings and specifications are intended to be complimentary. Any work shown in either of them, whether in the other or not, shall be executed according to the true intent and meaning thereof, the same as if set forth in all. Conflicts between the drawings and the specifications, or between the requirements set forth for the various contractors, shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by Design Professional and their decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires Contractor to work in areas previously finished by Owner, the Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall be responsible for patching and refinishing of such areas which may be damaged in this respect.

- G. Where two or more specified items/systems in the specifications and/or the drawings are in conflict, that requiring the highest order of professionalism and the most financially expensive products shall take precedence. Such questions shall be referred to the Design Professional for final decision.

## **1.9 MATERIALS AND EQUIPMENT**

- A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

## **1.10 SUBMITTALS**

- A. Contractor shall furnish, to the Design Professional, complete sets of submittals. Contractor shall review and sign submittals before submitting. Contractor shall provide submittals via electronic process (.PDF format) unless otherwise instructed. Refer to Division 01 specifications for additional requirements.
- B. Submittals shall be bound into sets per specification section (not division). The content of the submittal shall cover related items for a complete system as much as practical and items shall be identified with symbols or "plan marks" used on drawings whenever possible. Incomplete, piecemeal or unbound submittals will be rejected.
- C. Each submittal shall include a cover sheet providing the Approved Contractors company name, address, phone number and contact person (person to contact if there are questions about the submittal). The cover sheet shall also have adequate white space for the design professional review stamp as well as up-stream contractor stamps. The company providing the submittal shall be the same as that which meets the APPROVED CONTRACTOR requirements paragraph found later in this specification section (submittals without this identifying contractor information on the cover page will be rejected to ensure the Approved Contractor process is being followed).
- D. Design Professional will review submittals solely to assist contractors in correctly interpreting the plans and specifications.
- E. Contract requirements cannot be changed by submittals. Contract documents remain in force even if equipment is submitted which differs from contract drawings and specifications and that submittal is stamped as reviewed (or any other stamp verbiage).
- F. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- G. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.

H. Submit required information on all items in the project for the following systems (see table). Submittals shall be sorted and separately identified per specification section listed below.

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
27 00 10	Contractor Certifications					X		Note 1
27 00 10	Manufacturer Certification					X		Note 2
27 00 10	UTP No-Paint Notification					X		Note 7
27 05 26	Grounding Equipment		X			X		Note 6
27 05 26	Grounding Cabling		X			X		Note 6
27 05 26	Grounding Hardware		X			X		Note 6
27 11 00	Communications Cabling & Equipment		X			X	X	Note 6
27 11 00	Data Racks/Cabinets		X			X	X	Note 6
27 11 00	Cable Management		X			X	X	Note 6
27 11 00	UPS/Power Equipment		X			X	X	Note 6
27 11 00	As-Builts at Closeout							Note 3
27 12 00	Tester, UTP/Fiber		X			X		Note 4
27 12 00	Test Report at Closeout					X		Note 5
27 13 13	Communications Copper Backbone Cabling		X			X	X	
27 13 23	Communications Optical Fiber Backbone Cabling		X			X	X	
27 15 33	Communication Coaxial Horizontal Cabling		X			X	X	
27 45 00	Sound Masking System		X			X	X	
27 50 00	Intercom System		X			X	X	
27 51 29	Emergency Communication System		X			X	X	
27 60 00	Clock System		X			X	X	

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. Division 27 Contractor shall submit copies of the Contractor Certifications under section 27 00 10 (BICSI or IBEW/NECA Certifications) showing compliance with the specification. See Approved Contractors paragraph for details.</li> <li>2. Division 27 Contractor shall submit Manufacturer Certification under section 27 00 10. See Approved Contractors paragraph in this section for details, and further requirements listed in Cabling and Equipment specification section.</li> <li>3. Division 27 Contractor shall submit As-Built as specified in Cabling and Equipment section.</li> <li>4. Division 27 Contractor shall submit product information on UTP Tester and Fiber Tester. See testers specified in Testing and Documentation section.</li> <li>5. Division 27 Contractor shall submit Test Report as specified in Testing and Documentation section.</li> <li>6. Grounding and Bonding or Cabling and Equipment section submittals will not be opened or reviewed by the Design Professional until the Division 27 00 10 Contractor Certifications (see Note 1) and Division 27 Manufacturer Certifications (see Note 2) have been received and found to be acceptable by the Design Professional.</li> <li>7. Division 27 Contractor shall submit the "<u>Do Not Paint The UTP</u>" written notification (addressed to the General Contractor) for review by the Design Professional. This written notification is specified in the Telecommunications Cabling and Equipment section. The submittal process may be used as the vehicle to inform the General Contractor of the "Do Not Paint The UTP" requirement (and the mandatory corrections required if this were to happen, outlined in the Telecommunications Cabling and Equipment section) if the General Contractor acknowledges receipt of the written notification.</li> </ol>								

**1.11 OPERATION AND MAINTENANCE MANUALS**

- A. Operation and maintenance manuals shall be submitted to the Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals shall be bound in a three ring hard backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION  
 AND  
 MAINTENANCE  
 MANUAL  
 FOR  
 COMMUNICATIONS SYSTEMS  
 (PROJECT NAME)  
 (LOCATION)  
 (DATE)  
 SUBMITTED BY  
 (NAME, ADDRESS AND PHONE NUMBER OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Each section shall contain the following information for equipment furnished under this contract:
  1. Equipment and system warranties and guarantees.
  2. Installation instructions.
  3. Operating instructions.

4. Maintenance instructions.
5. Spare parts identification and ordering list.
6. Local service organization, address, contact and phone number.
7. Submittals with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.

**1.12 TESTS AND DEMONSTRATIONS**

- A. All systems shall be tested by Contractor and placed in proper working order prior to demonstrating systems to Owner.

**1.13 TRAINING AND DEMONSTRATIONS**

- A. Prior to acceptance of the communications installation, the Contractor shall provide to Owner, or their designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct Owner in the proper operation and maintenance of such systems.

1. Provide adequate notice to Owner as to when instruction will be conducted so appropriate personnel can be present.
2. Prepare the instruction format for a minimum of four Owner Representatives.

- B. Equipment training:

1. Manufacturer's representatives shall provide instruction on each major piece of equipment. Contractor shall provide instruction on all other equipment.
2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
3. Training shall be performed by qualified factory trained technicians.
4. Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

- C. System training:

1. Training sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

- D. The following are minimum requirements for Owner instruction:

Section	Description	Hrs. on Site	Presented By	Others Present	Remarks
27 11 00	Cabling and Equipment	2	Contractor		
27 45 00	Sound Masking System	1	Contractor		
27 50 00	Intercom System	4	Contractor		
27 60 00	Clock System	4	Contractor		
27 51 29	Emergency Communications System	2	Contractor		

- E. Each Contractor shall submit a certificate (in the project closeout submittals), signed by Owner stating the date, time and persons instructed and that the instruction has been completed to Owner's satisfaction. An example of a certificate form is as follows:

**CERTIFICATE OF SYSTEM DEMONSTRATION**

This document is to certify that the contractor has demonstrated the hereafter listed systems to Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: \_\_\_\_\_

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: \_\_\_\_\_

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

\_\_\_\_\_ Signature

\_\_\_\_\_ Date

Owner's Representative:

\_\_\_\_\_ Signature

\_\_\_\_\_ Date

**1.14 PERMITS, FEES, ETC.**

- A. Secure all required permits and pay for all inspections required in connection with the telecommunication systems work. Contractor shall post all bonds and obtain all licenses required by the State, City, County, and Federal Agencies.

**1.15 SUBSTITUTIONS**

- A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, Design Professional will approve it in an addendum. The Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

**1.16 APPROVED CONTRACTORS**

- A. **MANUFACTURER CERTIFICATION:** Contractor shall be a manufacturer certified installer for the structured cabling plant. A copy of the current annual manufacturer certification shall be provided with 27 00 10 submittals. Contractor is responsible for professionalism and installation practices in accordance with the manufacturer requirements and shall be authorized to provide an extended Manufacturer's Product Warranty with their installation. The specific warranty program that is acceptable for each solution is listed with the connectivity solution in specification section 27 11 00 COMMUNICATIONS SYSTEMS CABLING AND EQUIPMENT. Contractors shall provide proof upon request that they have maintained the Manufacturers Certification in good standing for at least six months prior to the overall project bid. Temporary or short term certifications (less than the standard 12 month annual certification described above) or case-by-case certifications are not acceptable.
- B. **CONTRACTOR CERTIFICATION:** Contractor shall meet one of the following two paragraphs and provide appropriate documentation in the 27 00 10 submittals:
  - 1. Contractor shall have BICSI Registered Installers and Technicians on staff and assign them to this project. The project shall be staffed at all times by Installers and Technicians who, in the role of lead craft-persons, will be able to provide leadership and technical resources for the remaining craft-persons on the project. A minimum of 30 percent of personnel shall be BICSI registered telecommunications installers. Of that number 15 percent shall be registered at the Technician Level, at least 40 percent shall be registered at the Installer Level 2, and the balance shall be registered at the Installer Level 1. Contractor shall provide BICSI certifications showing employee name, level, and expiration date. BICSI certificate for the highest level attained shall be submitted.
  - 2. Contractor shall have employees on staff and assigned to the project that are currently indentured in or have successfully completed the IBEW/NECA three-year Telecommunications Installer/Technician registered apprenticeship program. Contractor shall maintain a ratio of 1 Technician to 1 indentured Apprentice. Contractor shall provide documentation verifying the indentured status of Apprentices, and the Department of Labor Certificates of Completion for the Installer/Technicians.



- C. Contractor pulling the telecommunications cabling (if different from the prime Telecommunications Contractor) shall meet all the same BICSI or IBEW/NECA requirements, and requirements of this specification, as the prime Telecommunications Contractor.
- D. Contractor shall be located within 125 miles of the construction site to establish a potential two hour response time for ongoing customer needs after construction completion.

**1.17 ACCEPTABLE MANUFACTURERS**

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the drawing schedules, are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers, who do not submit prior to bidding, run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of Contractor and/or the manufacturer.
- C. If Contractor chooses to use a manufacturer listed as an equal, it shall be their responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

**1.18 QUALITY ASSURANCE**

- A. Contractor shall be a company specializing in telecommunication cable and/or accessories with a minimum of five years documented experience in installation of cable and/or accessories similar to those specified below.

**1.19 WARRANTY**

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
  - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
    - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
    - b. All Division 27 systems, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.

- B. Refer to other Division 28 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

#### **1.20 CHANGES IN THE WORK**

- A. A Contract Change Order is a written order to Contractor signed by Owner and Contractor, issued after the execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time may be changed only by Contract Change Order.
- B. Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Contract Change Order and shall be performed under the applicable conditions of the Contract Documents.
- C. The cost or credit to Owner resulting from a change in the Work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. Change Orders shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.
- D. It shall be the responsibility of Contractor before proceeding with any change to satisfy their self that the change has been properly authorized on behalf of Owner.

#### **1.21 GROUNDING AND BONDING OF SYSTEMS**

- A. All low voltage systems shall be subject to the Communications Grounding and Bonding specification section 27 05 26. For those systems which may require a specialized sub-contractor, the sub-contractor providing and installing systems shall also be responsible for grounding and bonding per this specification.

#### **1.22 COMPLETION**

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by Owner.
- B. When all the work is complete Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

**END OF SECTION 27 00 10**

## SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Communications General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this grounding and bonding system in compliance with the applicable standards, specifications and drawings. Contractor will provide and install all the required material to form a complete and operational system whether specifically addressed in the technical specifications or not.
- B. All division 27 low voltage systems shall adhere to these grounding and bonding requirements.
- C. Bond the following items within the telecommunications grounding system.
  - 1. All communications system active equipment.
  - 2. All POU and surge protection equipment.
  - 3. Raised floor systems.
  - 4. Underfloor grounding grids “supplemental bonding grids” for computer or telecommunications rooms.
  - 5. Metallic raceway systems, including metallic cable trays.
  - 6. Communications equipment enclosures (cabinets) or cross-connect frames.
  - 7. Broadband passive devices.
  - 8. Metallic splice cases.
  - 9. Metallic cable screens, armor or shields.
  - 10. All metal cable conduit.
  - 11. Electrical service panels in entrance facilities, telecommunications and equipment rooms.
  - 12. Wall and rack mounted grounding busbars.
  - 13. Exposed building steel that is within 6 feet of equipment racking systems.
  - 14. Building steel extending to earth in outside plant.
  - 15. All related bonding accessories.
- D. Quality Assurance:
  - 1. Grounding to conform to applicable building codes.
  - 2. Cable and equipment to be installed in a neat and workmanlike manner.
  - 3. Methods of construction that are not specifically described or indicated in the contract documents to be subject to the control and approval of the Owner representatives.
  - 4. Equipment and materials specified shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed.
  - 5. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to written approval by the Design Professional and or Owner representative.
  - 6. Materials and Methods shall comply in every way with above cited Standards and Codes.

### **1.3 SUBMITTALS**

- A. Submittal data for equipment, cabling, and hardware shall consist of catalog cuts showing technical data necessary to evaluate the materials with specific item designated by arrow or by being highlighted.

### **1.4 WORK BY OTHERS**

- A. The Intersystem Grounding Busbar located outside the main electrical service equipment will be installed as part of the main electrical gear and connected back to the various building grounding sources (ground rods, water pipe, building steel, etc.).

### **1.5 FIRESTOPPING**

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than “non-rated” shall constitute a wall that requires fire stopping in all penetrations/openings.

## **PART 2 - PRODUCTS**

### **2.1 GROUNDING AND BONDING PRODUCTS**

- A. Grounding and Bonding bases of design products are Panduit. See this Spec Section 1.02 D.5 regarding approved equals.
- B. Acceptable Grounding and Bonding Components.
  - 1. Telecommunications Main Grounding Busbar (TMGB) consisting of twenty-four 1/4" stud holes with 5/8" spacing, and six 3/8" stud holes with 1" spacing.
    - a. Panduit part number GB4B0624TPI-1.
  - 2. Telecommunications Grounding Busbar (TGB) consisting of twelve 1/4" stud holes with 5/8" hole spacing, and three 3/8" stud holes with 1" hole spacing.
    - a. Panduit part number GB2B0312TPI-1.
  - 3. Busbar Label Kit Busbar label kit includes one printed tag and one flame retardant cable tie.
    - a. Panduit part number LTYK.
  - 4. Data Rack Grounding Busbar, 19".
    - a. Panduit part number RGRB19U.
  - 5. Server Cabinet Grounding Busbar, Cage-nut Mounting, 19".
    - a. Panduit part number RGRB19CN.
  - 6. Bonding Backbone Splice Connectors: Irreversible Compression Splices C-TAPS
    - a. Panduit part number CTAPG3/0-12-Q

### **2.2 GROUNDING CABLING**

- A. The Intersystem Bonding Conductor (IBC) used for bonding the Intersystem Grounding Busbar to the Telecommunications Main Grounding Busbar (TMGB) shall be at a minimum, the same size as the largest TBB, green jacketed, stranded copper cable.

- B. The Telecommunication Bonding Backbone (TBB) used for bonding the Telecommunications Main Grounding Busbar (TMGB) to the Telecommunications Grounding Busbar (TGB) shall be a green jacketed, #3/0 AWG, stranded copper grounding cable.
  - 1. The TBB conductors shall be continuous and routed in the shortest possible straight-line path, avoiding changes in elevation and sharp bends.
  - 2. The TBB conductors shall be protected from mechanical damage and built to minimize splicing. Where splicing is required, they shall be done using irreversible compression splices (C-TAPS) built to that purpose. See the "Materials" section of this document for appropriate compression splices.
- C. The Equipment Bonding Conductor (EBC) used for bonding the TMGB or TGB to the data racks/server cabinets, any wall mounted low voltage system, the overhead cable tray system and to the electrical panel inside the telecom room inside the telecom room. The EBC shall be green jacketed #6 AWG stranded copper cable.
  - 1. The EBC is also used for bonding the TMGB or TGB to the primary cable tray outside the telecom room. The EBC shall be green jacketed #6 AWG stranded copper cable.
- D. The conductor used for bonding the TMGB or TGB to primary cable tray outside the telecom room shall be green jacketed #6 AWG stranded copper cable.

**2.3 ADDITIONAL GROUNDING CABLING REQUIREMENTS**

- A. Sizing the TBB conductor should follow the TIA-607-D bonding conductor sizing table. See the conductor sizing table below as published in the TIA-607-D
- B. TIA-607-D Conductor Sizing Table.

<b>TBC / TBB Linear Length m (ft)</b>	<b>Conductor Size (AWG)</b>
Less than 4(13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
20-26 (67-84)	3/0
26-32 (85-105)	4/0
32-38 (106-125)	250 kcmil
38-46 (126-150)	300 kcmil
46-53 (151-175)	350 kcmil
53-76 (176-250)	500 kcmil
79-91 (251-300)	600 kcmil
Greater than 91 (301)	750 kcmil

**2.4 GROUNDING HARDWARE**

- A. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #3/0 3/8” with 1” spacing.
  - 1. Panduit part number LCC3/0-38DW-X or approved equal.

- B. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #1/0 3/8" with 1" spacing.
  - 1. Panduit part number LCC1/0-38DW-X or approved equal.
- C. Two Hole Lug, Code Conductor, Long Barrel with Window, AWG #6 with 5/8" spacing.
  - 1. Panduit part number LCC6-14AW-L or approved equal.
- D. C-TAP Splices for copper-to-copper splicing or pigtail tap splicing.
  - 1. Panduit Part Number: STAPF Series. Actual part number must be selected according to AWG size of conductors being spliced.
- E. Paint Piercing Grounding Washer Kit with Antioxidant: Panduit parts.
- F. Bonding Screws, #12-24: Panduit part number RGTBSG-C.
- G. Grounding lug for bonding wire basket tray. For Conductors #1/0AWG to #6AWG code conductors.
  - 1. Cablofil Part Number: GNDCL or approved equal.

### **PART 3 - EXECUTION**

#### **3.1 STAR TOPOLOGY**

- A. The telecom grounding and bonding system shall be provided and installed in a star topology.
  - 1. Each building shall receive one Telecommunications Main Grounding Busbar (TMGB) in the designated telecom room or utility demarcation area (see below for location), and one Telecommunications Grounding Busbar (TGB) in each additional telecom room or identified specialty location (see below for locations).
  - 2. The TMGB shall receive a dedicated grounding connection back to the building Intersystem Grounding Busbar by Div.26. The building Intersystem Grounding Busbar is usually just outside the main electrical service gear (interior to the building, visible on the wall).
  - 3. All TGB's shall receive a dedicated grounding connection back to the TMGB.

#### **3.2 INSTALLATION AND LABELING**

- A. Install bonding and grounding system cables and hardware as indicated in accordance with the manufacturer's written instruction, and recognized industry practices.
- B. Identify all bonding and grounding cables and hardware in the telecommunication room and field locations.
  - 1. Provide labeling per Section 27 05 53 Identification for Communications Systems.

#### **3.3 INTERSYSTEM GROUNDING BUSBAR LOCATION:**

- A. See construction drawings and details for location.

### **3.4 TELECOMMUNICATIONS GROUNDING BUSBAR TMGB & TGB LOCATION:**

- A. See construction drawings and details for TMGB & TGB locations.

### **3.5 TELECOMMUNICATIONS ROOM LADDER RACK**

- A. All telecom room ladder rack shall be bonded together and to the telecommunications grounding busbar in that room.
- B. Bonding shall be accomplished per the following:
  - 1. Use the #6 AWG green jacketed cable listed in the cable paragraph.
  - 2. Use the #6 AWG two-hole lugs listed in the hardware paragraph.
  - 3. Use the bonding stud and bonding nuts listed in the hardware paragraph to secure the lug to the ladder rack.
  - 4. Drill holes in ladder rack to accommodate the two-hole lugs and bonding studs with bonding nuts.
  - 5. Install bonding conductors in a neat and orderly fashion so as not to droop or hang away from the material it is bonding.
  - 6. Use the #6 AWG two-hole lugs to bond to the busbar.

### **3.6 TELECOMMUNICATIONS ROOM RACKS AND CABINETS**

- A. All telecom room racks and cabinets shall be individually bonded to the copper busbar in that room (the TMGB or TGB) using a dedicated cable installation.
- B. Grounding the rack or cabinet to the copper busbar shall be accomplished per the following:
  - 1. Use the #6 AWG green jacketed copper cable listed in the cable paragraph.
  - 2. Use the #6 AWG two-hole lugs listed in the hardware paragraph to connect to the telecom room grounding busbar.
  - 3. Use the #6 AWG two-hole lugs listed in the hardware paragraph to connect to the rack or cabinet grounding busbar.
  - 4. Use the paint piercing washers listed in the hardware paragraph.
  - 5. Install bonding conductors in a neat and orderly fashion so as not to droop or hang away from the material it is bonding.
  - 6. Use the #6 AWG two-hole lugs to bond to the busbar.

### **3.7 TELECOMMUNICATIONS CABLE TRAY AND/OR WIRE BASKET**

- A. All installations of cable tray and/or wire basket runs shall be bonded to the nearest copper busbar in a telecom room (the TGB or TMGB) using #6 AWG green jacketed copper grounding conductor. The break point shall be at the same boundary as the UTP boundary between telecom rooms. Do not bond the cable tray or wire basket together across these boundaries as this could cause a grounding loop.
  - 1. All section of cable tray and/or wire basket shall be mechanically bonded together.
    - a. Sections of cable tray shall be bonded together with #6 AWG green copper grounding conductor and two-hole lugs referenced in this section 2.03.B or a cable tray manufactures bonding clamp and or UL rated basket tray connectors.

**3.8 ELECTRICAL PANEL**

- A. Bond TMGB and TGB to the local electrical panel that serves the room.
  - 1. See this spec. section 2.02.C for bonding conductor.
  - 2. Coordinate with the Division 26 contractor for electrical panel connection.

**END OF SECTION 27 05 26**



## SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. Furnish and install all materials, equipment and labels required as shown on the Drawings, Schedules and as specified.
- B. It is the intent of the Specifications, Drawings and Schedules that all labels be legible and provided in locations which are readily visible.
- C. Only those items affected by the installation of the project shall be labeled unless otherwise indicated.
- D. Project is a multi-year phased project. Refer to plans for phasing notes as they relate to delivery of equipment. Contractor must account for appropriate price increases and or secure storage of materials and equipment to comply with phasing requirements.

#### 1.2 STANDARDS

- A. Unless otherwise noted, all labels at distribution frames shall follow the color-coding scheme identified in ANSI/TIA/EIA 606 "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings".

#### 1.3 DRAWINGS AND SPECIFICATIONS

- A. The Contractor shall keep a detailed up-to-date record of the label information and placement of all labels installed as specified herein.

#### 1.4 SUBMITTALS

- A. Submit product data for the following:
  - 1. Labeling machine
  - 2. Labels.

#### 1.5 CLEANING

- A. The Contractor shall clean all surfaces prior to the attachment of labels. Follow the manufacturer's recommendations for cleaning.
- B. The Contractor shall follow the manufacturer's recommendations for affixing labels.

#### 1.6 ADDITIONAL IDENTIFICATION AND LABELING REQUIREMENTS

- A. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; pre-numbered plastic-coated type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- B. All field device labeling shall match the telecom room labeling for the corresponding cable.

- C. Jacks shall be numbered sequentially on the patch panel field, beginning at the top left, working across the row to the right, then down to the next row, etc.

## **PART 2 - PRODUCTS**

### **2.1 TERMINATION HARDWARE AND CABLE LABELS**

- A. Acceptable Manufacturers:
  - 1. Brady
  - 2. Brother
  - 3. DYMO
  - 4. Approved Equal

## **PART 3 - EXECUTION**

### **3.1 SPACES**

- A. Item: Entrance Facility (EF). The EF(s) for both copper and fiber service demarcation. Contractor shall label the backbone fiber and copper from the demarc to the MTR(s) in a visible location as entering the space with minimum 2" high black on orange machine printed labels.

Example: EF-001

- B. Item: Main Telecommunications Closet (MTR). The MTR for both copper and fiber terminations, has been pre-assigned and should be labeled by the contractor in a visible location as entering the space with minimum 2" high black on orange machine printed labels.

Example: MTR-A

- C. Item: Telecommunications Closet (TR). The TR has been pre-assigned and should be labeled by the contractor in a visible location as entering the space with minimum 2" high black on orange machine printed labels.

Example: TR-B

### **3.2 CABLING**

#### **3.02.1 Copper Cabling**

- A. Item: Building Copper cable (BC). The BC is an interior multi-pair copper riser cable extending from the MTR to TR.

- 1. Label Location:
  - a. . On the cable at both ends, near the hardware on which the cable is terminated.
- 2. Label Information:
  - a. The Cable identifier is the letters BC followed by the cable number (2 numeric characters) and the Cable Pair Count (4 numeric characters) and the identifying telecommunicate room letter. Identify both the beginning and end count. The Cable identifier is unique to the building. The Building copper cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Building Copper.

3. Method:
    - a. Black on white wire wrap machine printed label.
  4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One-line centered formatted text. Use dash as delimiter.
  5. Example: BC01-0001-0100-A
- B. Item: Horizontal Copper Cable. The Horizontal Copper Cable extends from the MTR or TR to any field side location requiring voice or data service within the defined serving boundaries of the said MTR or TR.
1. Label Location:
    - a. On the cable at both ends, near the hardware on which the cable is terminated.
  2. Label Information:
    - a. The Cable identifier is the letters (TR) followed by the serving TR identification letter and the 3 numeric characters field assigned by the Telecom Contractor during installation. The Cable identifier is unique to the TR. The Horizontal Copper Cable shall be recorded on the Communications Systems Identification Record document under the heading Jack ID. (see end of section)
  3. Method:
    - a. Black on white wire wrap machine printed label.
  4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One-line centered formatted text. Use dash as delimiter.
  5. Example: TR-A-001
- C. Item: Patch Cables (data). The patch cables are used to connect data services to the user service locations and are plugged into the electronics or patch panels at the other end of the cable.
1. Label Location:
    - a. On the end of the patch cable at the plug of both ends.
  2. Label Information:
    - a. Patch cable identifier (4 numeric characters). The patch cable identifier is sequential. The sequence is unique to the TR. The patch cable identifier shall begin with 0001 and end with the number corresponding to the quantity of jumpers installed in the closet. The patch cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading "Data Patch Cable Identifier" provided for each Telecommunication room. (see end of section)
  3. Method:
    - a. Black on white machine printed wire wrap labels.

4. Format:
    - a. The font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
  5. Example: 0001
- D. Item: Patch Cables (voice). The patch cables are used to connect voice services to the user service locations and are plugged into the electronics or patch panels at the other end of the cable.
1. Label Location:
    - a. On the end of the patch cable at the plug of both ends.
  2. Label Information:
    - a. Patch cable identifier (Alpha characters). The patch cable identifier is sequential. The sequence is unique to TR. The patch cable identifier shall begin with the letter A and end with the letter corresponding to the quantity of patch cables installed in the closet. When Z is reached. The sequence will start over again with double alpha characters. (AA) The patch cable identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading "Voice Patch Cable Identifier" provided for each Telecommunication room. (see end of section)
  3. Method:
    - a. Black on white machine printed wire wrap labels.
  4. Format:
    - a. The font shall be all Caps and as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
  5. Example: A to Z after Z follow with AA to ZZ.

### 3.02.2 Fiber Cabling

- A. Item: Building Fiber cable. The (BF) is an interior fiber riser cable extending from the MTR to the Telecommunications Closet (TR).
1. Label Location:
    - a. On the jacket or sheath of the cable at both ends (before the fanout or breakout point). Place the label near the cable entrance into the termination hardware and exterior to the termination hardware.
  2. Label Information:
    - a. The cable identifier is the letters BF followed by the cable number (2 numeric characters) and the Cable Strand Count (4 numeric characters) and the identifying telecommunication room letter. Both the beginning and end count. The cable identifier is unique to the building. The building fiber identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Building Fiber. (see end of section)
  3. Method:
    - a. Black on white wire wrap machine printed label and large enough to wrap around itself to protect the print.

4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format. Use dash as delimiter.
  5. Example: BF01-0001-0012-A
- B. Item: House Fiber cable (HF). The (HF) is an interior fiber cable extending from the MTR or TR to any work area within the building that is not a communications room.
1. Label Location:
    - a. On the jacket or sheath of the cable at both ends (before the fanout or breakout point). Place the label near the cable entrance into the termination hardware and exterior to the termination hardware.
  2. Label Information:
    - a. The cable identifier is the letters HF followed by the cable number (2 numeric characters) and the Cable Strand Count (4 numeric characters) and the identifying telecommunication room letter. The HF cable identifier is unique to the building. The HF identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading House Fiber. (see end of section)
  3. Method:
    - a. Black on white wire wrap machine printed label and large enough to wrap around itself to protect the print.
  4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format. Center text. Use dash as delimiter.
  5. Example: HF01-0001-0012-A
- C. Item: Coax Backbone Cable. The Coax Backbone cable (R11) is an interior coax riser cable typically extending from the MTR to the Telecommunications Closet (TR).
1. Label Location:
    - a. On the jacket or sheath of the cable at both ends six inches from the terminated F connector is installed.
  2. Label Information:
    - a. The cable identifier is the letters R11 followed by the cable number (2 numeric characters) and the identifying (to and from) MTR and or TR. The cable identifier is unique to the building. The coax backbone identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document.
  3. Method:
    - a. Black on white wire wrap machine printed label and large enough to wrap around itself to protect the print.

4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format. Use dash as delimiter.
  5. Example: R11-01-MTR-A\_TR-B
- D. Item: Horizontal Coax Cable. The Horizontal Coax Cable (R6) extends from the MTR or TR to any field side location requiring cable television service within the defined serving boundaries of the said MTR or TR.
1. Label Location:
    - a. On the cable at both ends, near the terminated compression F connector.
  2. Label Information:
    - a. The Cable identifier is the letters (TR) followed by the serving TR identification letter and the 3 numeric characters field assigned by the Telecom Contractor during installation and followed by R6. The Cable identifier is unique to the TR. The Horizontal Coax Cable shall be recorded on the Communications Systems Identification Record document.
  3. Method:
    - a. Black on white wire wrap machine printed label.
  4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One-line centered formatted text. Use dash as delimiter.
  5. Example: TR-A-001R6

### **3.3 TERMINATION HARDWARE**

#### **3.03.1 Copper Termination Hardware**

- A. Item: Outlet faceplate. The outlet faceplate is typically a 2-port or 4-port faceplate.
1. Label Location:
    - a. On the top of the faceplate in the outlet location window and behind the clear plastic window.
  2. Label Information:
    - a. Outlet location number (8 alpha and numeric characters). The information shall match the outlet location number assigned by the contractor during installation. Outlet numbers are unique to the serving telecommunication room. Each outlet/jack number assigned by the Contractor and the room the jack is installed to shall be recorded on the Communications Systems Identification Record document under the heading Jack Identification and Jack Room Location.
  3. Method:
    - a. Manufacturer's white paper inserts. Print the information on an adhesive label and affix the label to the paper insert. Labels shall not be affixed to the clear plastic window. The orientation of the text on the label for the 2-port faceplates shall match the 4-port faceplates. Use only machine printed labels sized for purpose.

4. Format:
    - a. Font should be sized to fill the area of the strip. The font should be Helvetica or equal and bold. One line format.
  5. Example: TR-X-XXX
- B. Item: Horizontal Copper Cable Patch Panels. The patch panel for horizontal copper cable is in the MTR or TR and installed in the equipment rack in pre-assigned rack units. The patch panel provides a connection point for voice and data service in the MTR or TR to any field side location within the defined serving boundaries of the said MTR or TR.
1. Label Location:
    - a. In the manufactures designated port label location.
  2. Label Information:
    - a. Outlet location number (8 alpha and numeric characters). The information shall match the outlet location number assigned by the contractor during installation. Outlet numbers are unique to the serving telecommunication room. Each outlet/jack number assigned by the Contractor and the room the jack is installed to shall be recorded on the Communications Systems Identification Record document under the heading Jack Identification and Jack Room Location.
  3. Method:
    - a. Black on white machine printed manufacture patch panel labels.
  4. Format:
    - a. Font shall be sized to be readable, fitting all characters required within the manufacture provided area. The font should be Helvetica or equal and bold. One line format.
  5. Example: TR-A-001
- C. Item: Telco Patch Panels. The BC cables are terminated on a 25 or 50 port/pair voice Cat.3 RJ45 19in 1RU patch panel. If a 25 or 50 port/pair patch panel is not provided by the selected cable manufacturer from Sec. 27 11 00-2.01B. A patch panel from any of the other approved manufacturers in Sec. 27 11 00-2.01B can be submitted for approval by the Engineer.
1. Label Location A:
    - a. One single label on the face of the patch panel identifying the BC and serving TR.
  2. Example: BC01-A
  3. Label Location B:
    - a. At the provided patch panel port label location.
  4. Label Information:
    - a. Copper Cable count (as applicable) per port.
  5. Method:
    - a. Black on white machine printed adhesive Labels.
  6. Format:
  7. Font should be sized to be readable and to fit all information required without overlap of text. The font should be Helvetica or equal. One line format.

8. Example: Port 1: 0001 Port 2: 0002  
"Port 1:" is for example purpose only and is not to be included on label.

### 3.03.2 Fiber Termination Hardware

- A. Item: Fiber Housing enclosures including the following (FH).
  1. CCH (Closet Connector Housing)
  2. WCH (Wall-mountable Closet Housing)
  3. Label Location:
    - a. On the outside of the enclosure and on the flat facing (i.e., front) surface in the top left corner.
  4. Label Information:
    - a. The Fiber enclosure identifier is the letters FH followed by the enclosure number (4 numeric characters). The Fiber enclosure identifier is unique to the Building. The fiber enclosure identifier shall be assigned by the Contractor and recorded on the Communications Systems Identification Record document under the heading Fiber housing.
  5. Method:
    - a. Machine printed 2.25" W x 1.25" H component Label.
  6. Format:
    - a. Font should be sized to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
  7. Example: FH-0001

### 3.03.3 Fiber Terminations

- A. Item: Building fiber terminations. The connector layout within each enclosure may vary. In general, the columns of fiber adapters are grouped in units of six duplex adapters per connector panels. Columns count from left to right. Terminations positions within a column count from top to bottom. The connector adapters are duplex LC. All connectors will be LC.
  1. Label Location:
    - a. On the inside front panel of the enclosure in the location identified by the manufacturer for the label. Use the manufacturer's label placard that is enclosed with the hardware.
  2. Label Information:
    - a. The label information includes a Panel identifier, the Building Fiber cable identifier, and the fiber strand assignment. The Panel identifier (1 alpha character). The Panel identifier shall begin with the letter A and end alphabetically corresponding to the quantity of connector panels in the enclosure. All occupied panels within the enclosure shall be labeled. The Panel identifier is unique to the enclosure. The Panel identifier is assigned by the Contractor. The Building Fiber cable identifier is defined under the Item: Building Fiber cable (BF). The BF strand count is unique to the BF. The sequence begins with 0001.
  3. Method:
    - a. Machine printed component Labels. Sized to fit the provided labeling card of the fiber housing manufacturer.



4. Format:
  - a. Font should be sized to fill the label space with the information without overlap of the next column. The font should be Helvetica or equal and bold. One line format.
  
5. Example:
 

	A-BF01-0001	B-BF02-0001	C-BF03-0001
	A-BF01-0002	B-BF02-0002	C-BF03-0002
	A-BF01-0003	B-BF02-0003	C-BF03-0003
	A-BF01-0004	B-BF02-0004	C-BF03-0004
	A-BF01-0005	B-BF02-0005	C-BF03-0005
	“ “	“ “	“ “
	A-BF01-0012	B-BF02-0012	C-BF03-0012

**3.03.4 Coax Distribution Hardware**

- A. Item: Coax Distribution Hardware. The coax distribution hardware consists typically of amplifiers, splitters, and taps.
  1. Label Location:
    - a. On the face of each piece of distribution hardware.
  
  2. Label Information:
    - a. The label information identifies the MTR or TR that it is installed in. Followed by the Prefix: AMP, SP and TP for amplifier, splitter and tap. The Prefix shall be followed by an alpha character starting with (A) at the first piece of each type of distribution hardware in the telecom room. The alpha character will be followed by (2) numerical characters identifying individual output ports on each piece of hardware.
  
  3. Method:
    - a. Machine printed component labels. Sized to fit and be legible.
  
  4. Format:
    - a. Font should be sized to fill available space with the information without overlap of the next label. The font should be Helvetica or equal and bold. One line format.
  
  5. Example:
    - a. Amplifier: TR-A\_AMP-A\_01
    - b. 4 Port Splitter: TR-A\_SP-A\_01, SP-A\_02, SP-A\_03, SP-A\_04
    - c. 4 Port Tap: TR-A\_TP-A\_01, TP-A\_02, TP-A\_03, TP-A\_04

**3.4 EQUIPMENT AND EQUIPMENT RACKS**

- A. Item: Data Racks. The data racks are typically 19” free-standing or wall-mounted racks or cabinets.
  1. Label Location:
    - a. Top front and back cross bars of each data rack.
  
  2. Label Information:
    - a. The data rack identifier is the letters (DR) followed by the rack number (2 numeric characters). Start numbering from the front of the equipment rack, left to right. The equipment rack label information is shown on the drawing details. The equipment rack identifier is unique to the room.

3. Method:
  - a. Machine printed 2.25" W x 1.25" H minimum component labels.
4. Format:
  - a. All capital letters. The font should be sized to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
5. Example: DR01

### **3.5 GROUNDING AND BONDING**

- A. Item: Telecommunications Main Grounding Busbar (TMGB).
  1. Label Location:
    - a. On the left side of the busbar on the busbar wall standoff.
  2. Label Information:
    - a. The letters TMGB. The TMGB is unique to the building. The identifier information is identified on the grounding schematic detail of the drawings.
  3. Method:
    - a. Black on white machine printed 2.25" W x 1.25" H minimum component Label.
  4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
  5. Example: TMGB
- B. Item: Telecommunications Grounding Busbar (TGB).
  1. Label Location: On the left side of the busbar on the busbar wall standoff.
  2. Label Information:
    - a. The letters TGB followed by the sequence number (2 numeric characters). The sequence shall be unique to the building. The identifier information is identified on the grounding schematic detail on the drawings.
  3. Method:
    - a. Black on white machine printed 2.25" W x 1.25" H minimum component Label.
  4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label holder space with the information. The font should be Helvetica or equal and bold. One line format.
  5. Example: TGB-01

- C. Item: Telecommunications Bonding Backbone (TBB). The Telecommunications Bonding Backbone (TBB) bonds the TMGB to the TGB. There may be multiple TBB's. The quantity of TBB's depends on the methods used to interconnect the TGB's.
1. Label Location:
    - a. On the conductor at each end and at each break in the insulation (for connection to another conductor or a busbar). The label shall be placed near the end of the insulation.
  2. Label Information:
    - a. The letters BB followed by the sequence number (1 numeric character). The sequence number shall be unique to the building. The identifier information is identified on the grounding schematic details on the drawings.
  3. Method:
    - a. Black on white machine printed 2" W x .75" H wire wrap label.
  4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
  5. Example: BB-1
- D. Item: Telecommunication Bonding Conductor (TBC). The TBC bonds the Intersystem Building Busbar to the TMGB. Typically, there is only one TBC.
1. Label Location:
    - a. On the conductor at each end. The label shall be placed near the end of the conductor at the connection to the Intersystem Building Busbar and the TMGB.
  2. Label Information:
    - a. The letters TBC followed by the sequence number (1 numeric character). The sequence number shall be unique to the building. The identifier information is identified on the grounding schematic detail on the drawings.
  3. Method:
    - a. Black on white machine printed 2" W x .75" H wire wrap label.
  4. Format:
    - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
  5. Example: TBC-1
- E. Item: Equipment bonding conductor (EBC). The equipment bonding conductor (EBC) bonds the TMGB and TGB to other cable tray within or outside the telecommunication room, data racks, and other miscellaneous metallic items, including electronic equipment.
1. Label Location:
    - a. On the conductor at each end and at each break in the insulation (for connection to another conductor or a busbar). The label shall be placed near the end busbar or the break in the insulation whichever applies.

2. Label Information:
  - a. The letters EBC followed by the sequence number (3 numerical characters). The sequence number shall be unique to the telecommunications closet. The contractor shall assign the numbers as necessary to accomplish the installation.
3. Method:
  - a. Black on white machine printed wire wrap Label. .50" W x .375" H.
4. Format:
  - a. All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format.
5. Example: EBC-001



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## SECTION 27 11 00 - COMMUNICATIONS CABLING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Communications General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

#### 1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
  - 1. National Electrical Code
  - 2. Local Electrical Code
  - 3. National Fire Protection Association
  - 4. National Electrical Manufacturers Association
  - 5. Standards of Institute of Electrical and Electronic Engineers
  - 6. Applicable Building Codes
  - 7. Occupational Safety and Health Act
  - 8. Wisconsin Administrative Codes
  - 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
  - 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
  - 11. ANSI TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
  - 12. ANSI TIA-568-C.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
  - 13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
  - 14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
  - 15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
  - 16. ANSI TIA-569-D Telecommunications Pathways and Spaces
  - 17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
  - 18. ANSI TIA-598-D Optical Fiber Cable Color Coding
  - 19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
  - 20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - 21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
  - 22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

## **1.4 SUBMITTALS**

- A. Manufacturer and Contractor Certifications are required submittals in the Division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.
- B. Submittal data for cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

## **1.5 WORK BY OTHERS**

- A. In general, the following is provided or is of note:
  - 1. Electrical Contractor will provide field device back boxes and conduit paths for use by Division 27 Contractors.
  - 2. The project painter may not be aware that ANY paint overspray (or direct application) of paint of any type to the UTP (unshielded twisted pair, generally called data cabling) voids the manufacturer's warranty and violates this specification. Paint may not be chemically or physically removed in any way once applied to the data cabling. Any cabling with paint overspray shall be fully replaced.

## **1.6 FIRESTOPPING**

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than "non-rated" shall constitute a wall that requires fire stopping in all penetrations/openings.

## **PART 2 - PRODUCTS**

### **2.1 COPPER UTP CABLE AND CONNECTIVITY PRODUCTS**

- A. Cabling and connectivity products (devices, cover plates, patch panels, insulation displacement connectors, etc.) must be part of a matched solution, provided by manufacturers that have been tested together and provide a fully certified end to end system.
- B. Acceptable Manufacturers:
  - 1. Belden Cat6 UTP connectivity (angled, modular patch panels) w/ Belden 3600 Series Cat6 cable with 25-year Belden IBDN Component Warranty and Application Assurance Program provided by a Belden Certified System Vendor (CSV).
  - 2. CommScope Uniprise Cat6 UTP connectivity (angled, modular patch panels) w/ CommScope Uniprise UltraMedia 7504 series Cat6 cable, with Uniprise 20-year product and performance warranty.
  - 3. Leviton Cat6 Extreme UTP connectivity (angled, modular patch panels) w/ Berk-Tek LANmark 1000 Cat6 cable with BLT limited lifetime warranty provided by Leviton Preferred Network Installers (PNI).
  - 4. Ortronics TracJack Cat6 UTP connectivity (angled, modular patch panels) w/ Superior Essex Data Gain Cat6 cable, with the 25 year "nCompass" system warranty provided by an Ortronics CIP (Certified Installer Plus).
  - 5. Panduit Mini-Com Cat6 UTP connectivity (angled, modular patch panels) w/ General GS6000E Cat6 cable with PanGenPlus 25-year system warranty provided by a Panduit Certified Installer.



C. Cable Jacket Rating:

1. Plenum

D. Additional Cabling and Connectivity Requirements:

1. Furnish and install cable between telecommunications room and field device locations as noted on the drawings.
2. Each field jack shall have a dedicated cable.
3. Provide cable terminations at telecommunications room.
4. Provide terminations at all field locations with an 8 pin, 8 conductor (RJ45 type) modular jack and flush wall plate per drawings.
  - a. Telecom Room Jack Color: Black
  - b. Field Side Jack Color: See print for closet designations
    - 1) Orange
    - 2) Yellow
    - 3) Blue
    - 4) Black
    - 5) Red
    - 6) Gray
    - 7) White
    - 8) Green
5. Terminate using T568B wiring schematic unless noted otherwise.
6. Provide wall faceplates from the same connectivity manufacturer per location requirements for all field devices.
7. Faceplates shall match material and color of the electrical wiring device cover plates. See Spec. 26 27 26 Wiring Devices.
8. Configure faceplates as required for individual field locations per drawings.
9. Blanks shall be installed in all empty jack locations.
10. All patch panels shall be high-density 48 port in 1RU. Unless noted otherwise.
11. Occurrences of a single telecom room serving multiple floors.
  - a. The contractor shall coordinate with the owner if separation of patch panels per floor in the data rack will be required.
  - b. The contractor shall refer to other spec sections and project drawings for typical patch panel layouts and instructions if patch panel separation per floor isn't necessary.

## 2.2 TELECOM ROOM EQUIPMENT

- A. Please see table below for hardware selection:

HARDWARE	Manufacturer	Part No.
Data Rack, Two Post	CPI	55053-703
Data Cabinet, Wall Mounted	CPI	12419-748
Vertical Cable Manager 10-inch	CPI Evolution g3	35573-703
12-inch	CPI Evolution g3	35574-703
Horizontal Cable Manger 2 RU	CPI Evolution	35441-702

HARDWARE	Manufacturer	Part No
Horizontal Cable Tray 12-inch ladder 6-inch basket 8-inch basket 12-inch basket	CPI Match this spec. 2.04. B Match this spec. 2.04. B Match this spec. 2.04. B	11275-712
Vertical Cable Tray 12-inch ladder	CPI	11275-712

- B. The table above is design basis information.
1. Eaton B-Line products are also an acceptable alternative to the CPI items in the table above.
  2. The Manufacturer selected from this spec section, 2.01, COPPER UTP CABLE AND CONNECTIVITY PRODUCTS, paragraph B, that have their own hardware equal to the CPI products listed in the table, may be substituted in place of the CPI products listed.

### 2.3 WIRE BASKET HORIZONTAL CABLE MANAGEMENT

- A. Wire basket shall be provided and installed (generally outside of telecom rooms only) as shown on the plans.
- B. Acceptable Manufacturers are:
1. Chatsworth Products (CPI), OnTrac Wire Mesh Cable Tray
  2. Wire Basket Tray (WBT) Shaped Wire Basket Tray
  3. Cooper B-Line, Flextray Cable Management
  4. Legrand Cablofil, Wire Mesh Cable Tray
  5. MonoSystems, Mono-Mesh Wire Basket Cable Tray
- C. Additional Wire Basket Requirements:
1. All wire basket and hardware shall be galvanized (no other coatings) applied after product fabrication. This is to ensure a product that is made of an electrically conductive material for grounding purposes.
  2. It is the responsibility of the contractor installing the wire basket tray to coordinate the route indicated on the construction drawings with all other trades. Intersecting mechanical, fire alarm, or electrical systems shall not obstruct the fill ratio of the specified wire basket tray in any way.
  3. Whenever possible the Contractor shall continue the basket around corners and changes in elevation by applying the factory instructions for cutting and bending the material rather than stopping the material, forcing the cable to jump from one installation to the other.
  4. The Contractor shall only cut the material with manufacturer approved cutters which leave a square edge, rather than bolt cutters which leave a sharp edge that can damage cables and severely injure installers or the Owner in the future.
  5. Wire basket is shown in part diagrammatically on the plans. Conduit sleeves are shown passing through walls with a stub symbol on each end to represent what shall be installed.
  6. The Contractor shall install the wire basket at and to the intended locations shown on the plans.
    - a. The maximum air gap between wire basket and a conduit sleeve passing through a wall horizontally shall be one foot (12").
    - b. The maximum air gap between wire basket and the cable destination vertically shall be two feet (24").

## **2.4 LIGHTNING PROTECTION**

- A. Lightning protection shall be provided for all cabling that does not remain fully inside the building envelope.
  - 1. All lightning protection provided for cabling that serves a network device shall be rated for 1GB data transmission speeds at a minimum and shall support Power Over Ethernet.
- B. Acceptable Manufacturers are:
  - 1. DITEK Surge Protection
  - 2. L-Com inc.
- C. Additional Lightning Protection Requirements:
  - 1. All cabling 25 pair or larger shall use an enclosed Building Entrance Terminal. This terminal shall be sized to accommodate all incoming cable pairs (full of 5 pin modules). Module selection shall be determined by the application chart found in manufacturer literature.
  - 2. For applications smaller than 25 pair, the proper manufacturer recommended solution is acceptable (enclosed or not).

## **2.5 FIRE ALARM PANEL CONNECTIONS**

- A. Two fire alarm panel information drops shall be furnished and installed by Contractor for each fire alarm head end panel. These drops shall be provided when required, whether they are pictorially shown on the plans or not.
- B. Acceptable Manufacturers:
  - 1. UTP cabling shall be the same as the Contractor will be installing per paragraph 2.01.B of this specification.
  - 2. Terminate cabling on standard RJ45 modular Jacks and install in a 2-port surface mount housing from the cabling manufacturer noted per paragraph 2.01.B of the specification.

## **PART 3 - EXECUTION**

### **3.1 UTP NO-PAINT WRITTEN NOTIFICATION REQUIREMENT**

- A. Many painters do not know that paint overspray of any quantity on voice/data UTP cabling (called UTP from here on) voids the manufacturer's extended warranty required by the specification. The Telecom Contractor shall notify the General Contractor in writing that the UTP cannot be painted (not even the slightest bit of overspray) and inform him or her that mechanical or chemical removal of paint is not allowed but rather full replacement of any cable that has received any amount of paint or paint overspray shall be fully replaced (no splicing allowed). This notification shall occur at least 30 days prior to any UTP being installed in the facility or brought on-site for storage.

### **3.2 INSTALLATION AND LABELING**

- A. Install telecommunication systems cables and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
  - 1. In general, all interior cables are installed in conduit.
  - 2. In general, all interior cables are installed in the wall spaces, not in conduit.

3. D rings are allowed in telecommunications room as needed.
  4. Contractor shall use hook and loop type fasteners on all UTP telecommunications cable. Tie wraps may be temporarily used loosely for dressing UTP cables during installation if they are removed before final inspection. Any tie wrap found in place around UTP cable tight enough that a 0.5" wooden dowel cannot be inserted into the bundle at the tie wrap location shall therefore obligate the Contractor to replace those potentially damaged UTP cables at the Design Professionals discretion, whether they pass electronic testing or not.
  5. Tie wraps may be used carefully on OSP and armored cabling at light tension levels which do not result in any visible cable jacket deformation.
  6. If unarmored fiber is specified without innerduct for any reason, tie wraps are forbidden on that cabling.
  7. Any and all tie wraps used in the project shall be trimmed flush at the locking device using a fully flush cutter tool for safety. Any tie wrap found with a sharp point shall be removed by the Contractor and replaced without additional compensation.
- B. Identify all fiber, copper, and coaxial cables that terminate in the telecommunication room as to field location.
1. Provide labeling per Div.27 Section 27 05 53 Identification for Communications Systems.
- C. After completion, all cables shall be thoroughly tested in accordance with the Division 27 Testing and Documentation section.
1. Contractor shall provide all instruments for testing the cables.
  2. Contractor shall demonstrate in the presence of Owner's representative that the telecommunications system is complete and operational.
  3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and posted in each Telecom Room within 3 days.
1. Two hard copies shall be created for each Telecom Room detailing the entire structured cabling plant and labeling scheme after installation. One hard copy shall consist of (at a minimum) the Telecom plans marked with permanent ink to show the labeling used at each field location, and a table or spreadsheet (for example, an 8 1/2" x 11" printed Excel file) that lists all the patch panel jacks in a column sequentially, followed by a cross reference column identifying the room name/number that the corresponding jack is in. This is the only part of the labeling process in which room name/numbers are acceptable. The second hard copy shall be identical to the first one. One copy shall be posted in each corresponding Telecom Room, and the other copy shall be submitted to the Design Professional for review according to the submittal process identified in the shop drawing paragraph of Specification Section 27 00 10. This second copy will then be forwarded to Owner.

**END OF SECTION 27 11 00**

## SECTION 27 12 00 - COMMUNICATIONS TESTING AND DOCUMENTATION

### PART 1 - GENERAL

#### 1.1 GENERAL

- A. Refer to Division 00 – Procurement, Contracting and Warranty Requirements and Division 01 - General Requirements, which all apply to work under this section.

#### 1.2 PURPOSE

- A. The purpose of the testing is to ensure proper installation of the telecommunications cabling system.

#### 1.3 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Submit product data for the following:
  - 1. Hand-held testing equipment manufacturer, model, last calibration date/calibration due date and software version.
  - 2. Injector equipment manufacturer, model, and software version.

#### 1.4 REFERENCES

- A. The following Performance Standards shall be followed. Unless otherwise stated, where Performance Standards conflict with manufacturer's recommendations, the more restrictive shall be applied:
  - 1. TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
  - 2. TIA-526-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
  - 3. TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
  - 4. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
  - 5. TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
  - 6. TIA-568-C.3 Optical Fiber Cabling Components Standard
  - 7. TIA-568-C.4 Broadband Coaxial Cabling and Components Standard

#### 1.5 TEST EQUIPMENT

- A. Test Equipment: JDSU Certifier40G, Fluke DSX-5000, Fluke DTX-1800 or TIA & Connectivity Manufacturer approved Level IV (or better) Certifier.
- B. The software version for the testers shall be the latest version available.
- C. The tester must have been calibrated within the last 12 months with calibration date noted on all test results.

## **1.6 LINK DEFINITION FOR THE PROJECT**

- A. A link consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 2 meters of test equipment lead from the main unit of the hand-held tester to the local connection, and up to 2 meters of test equipment lead from the remote unit to the remote connection. A total length of up to 94 meters (308 feet).
- B. The connection to the equipment at each end of the link is not included in the link definition.

## **1.7 CHANNEL DEFINITION FOR THE PROJECT**

- A. A channel consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 7 meters for the cross-connect and equipment cable, and up to 3 meters for the work area equipment cable. A total length of up to 100 meters (328 feet).
- B. The connection to equipment at each end of the channel is not included in the channel definition.

## **PART 2 - COPPER CABLING ACCEPTANCE TESTING**

### **2.1 ACCEPTANCE TESTS**

- A. The following field acceptance tests shall be performed for twisted - pair cabling:
  - 1. Wire Map (continuity).
  - 2. Length.
  - 3. Attenuation.
  - 4. NEXT.
  - 5. ACR-F
  - 6. Delay and delay skew.
  - 7. Return loss.
  - 8. Power sum crosstalk (PSNEXT and PSACR-F).

### **2.2 TEST EQUIPMENT SET-UP AND TEST PARAMETERS**

- A. Autotest: Use the Autotests to perform the required tests. Customize the Autotest as necessary to satisfy testing requirements and parameters.
- B. Cable Type: Select the cable type being tested. Cable Type may vary. Always change the NVP for the type of cable being tested.
- C. Frequency Range: The frequency range for category 6 tests shall be 1 MHz to 250 MHz.
- D. Cable Pairs: Test all cable pairs. Select all pairs for TEST and all pairs for Pass/Fail criteria for Autotest.
- E. Length Units: Cable length test results shall be in feet.
- F. Date Style. The date style shall show month, day, and year. Date shall be the date the test is conducted.
- G. Language: The language shall be English.

## **2.3 TEST PROCEDURE**

- A. Testing shall be performed with the tester at the distribution frame and the remote unit at the Work Area Outlet.
- B. A Channel OR Permanent Link certification test will be performed as outlined in the specific job description.
- C. Test leads and test hardware have limited life-cycles. Inspect and replace the test leads as necessary.
- D. Use only test leads specified by the test equipment manufacturer.
- E. Strictly follow the test equipment manufacturer's instructions for equipment setup, initialization, and calibration.

## **PART 3 - MULTIMODE FIBER TESTING**

### **3.1 ACCEPTABLE TESTS**

- A. The following field acceptance tests shall be performed for multimode fiber:
  - 1. End to end attenuation & length testing at 850 nm and 1300 nm for backbone links.
  - 2. End to end attenuation & length testing at 850 nm and 1300 nm for horizontal links.

### **3.2 TEST PARAMETERS**

- A. The following test parameters shall be adhered to:
  - 1. The transmit test port & test jumpers must be inspected and (if required) cleaned prior to testing. An image of the endfaces with endface condition pass/fail result must be included with the test report. Endface pass/fail conditions are outlined in TIA-568-C Annex E.
  - 2. Fiber under test endfaces must be inspected and cleaned. An image with pass/fail criteria for endface condition must be included in the test results per TIA-568-C Annex E.
  - 3. Test jumpers must be of the same fiber core size and connector type as the cable system (e.g., 50/125 um jumpers for a 50/125 um system).
  - 4. As required in TIA-526-14, The testers must be referenced prior to testing by the one jumper method for Links and the three-jumper method for channels. The reference method preferred must be noted in the job specifications prior to testing.
  - 5. The power meter and the light source must be set to the same wavelength.
  - 6. The power meter must be calibrated and traceable to the National Institute for Standards and Technologies (NIST).
  - 7. The light source or OTDR must operate within the range of 850+30 nm or 1300+20nm for multimode testing in accordance with ANSI/TIA/EIA-526-14.
  - 8. All system connectors, adapters, and jumpers must be properly cleaned before measurements are taken.

## **PART 4 - SINGLEMODE FIBER TESTING**

### **4.1 ACCEPTANCE TESTS**

- A. The following field acceptance tests shall be performed for single mode fiber:
  - 1. End to end attenuation and length testing at 1310 nm and 1550 nm.

## 4.2 TEST PARAMETERS

- A. The following tests parameters shall be adhered to:
1. The transmit test port & test jumpers must be inspected and (if required) cleaned prior to testing. An image of the endfaces with endface condition pass/fail result must be included with the test report. Endface pass/fail conditions are outlined in TIA-568-C Annex E.
  2. Fiber under test endfaces must be inspected and cleaned. An image with pass/fail criteria for endface condition must be included in the test results per TIA-568-C Annex E.
  3. Test jumpers must be of the same fiber core size and connector type as the cable system (e.g., singlemode jumpers for a singlemode system).
  4. As required in TIA-526-7, The testers must be referenced prior to testing by the one jumper method. The reference method preferred must be noted in the job specifications prior to testing.
  5. The power meter and the light source must be set to the same wavelength.
  6. The power meter must be calibrated and traceable to the National Institute for Standards and Technologies (NIST).
  7. The light source or OTDR must operate within the range of 1310+10 nm or 1550+20nm for singlemode testing in accordance with ANSI/TIA/EIA-526-7.
  8. All system connectors, adapters, and jumpers must be properly cleaned before measurements are taken.

## PART 5 - TESTING DOCUMENTATION

### 5.1 DOCUMENTATION

- A. The Test Documentation requirements are the minimum requirements. Other details of presentation and recording methods will be discussed with Owner and Design Professional. Gain approval from Owner and Design Professional of the test documentation format and content prior to full-scale testing. Coordinate with Owner and Design Professional to get representative sample of the documentation format and content for review.
- B. Provide Owner with a printed copy of ONLY the summary report of all tests, the electronic file of the test results for each test on CD or USB, and the electronic copy of the summary report on CD or USB. Do not print out each report.

### 5.2 TEST REPORT

- A. The following header fields on each test report shall contain the appropriate information. These are minimum requirements.
1. Circuit ID
  2. Test Result
  3. Owner
  4. Test Equipment Serial Number
  5. Software Version
  6. Calibration Date
  7. Date
  8. Cable Type
  9. NVP
  10. Building
  11. Closet



- B. The information in each user definable header field on each test report shall contain the information as follows.
1. Circuit ID: Indicate the outlet location number and jack number under test
  2. Owner: Indicate the owner of the test equipment
  3. Date: Indicate the date of the test
  4. Cable Type: Indicate the cable type being tested
  5. NVP: Indicate the field measured NVP
  6. Building: Indicate the building where the cable is being tested
  7. Closet: Indicate the closet identifier where the cable is terminated
- C. The minimum test result information on each report shall include the data for the tests identified in the Acceptance Tests paragraph of each applicable testing part.
- D. Contractor shall provide the test data in a complete and consistent format. Printed test results shall be printed from a laser printer.
- E. The contractor shall verify that a report for each jack in the Project is contained in the file list.
- F. Two weeks (14 days) prior to scheduled telecommunications systems start-up date Design Professional shall receive from Contractor complete printed cable performance test results via the submittal process (see 27 00 10). Start-up shall not commence unless test results are submitted.

### **5.3 ELECTRONIC COPY**

- A. The electronic copy of the test results shall be on CD or USB.
- B. The electronic copy shall be labeled. The label shall read:
- Project Name  
building name (BLDG. No. x)  
"Copper/Fiber Test Results"  
"CD No." X of X  
date (month and year)
- C. The files shall not be altered from the original test equipment output.

**END OF SECTION 27 12 00**

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## SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. This Section identifies the specification for copper backbone cable.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this copper backbone cabling system in compliance with the specifications and drawings. Contractor will provide and install all the required material to form a complete system whether specifically addressed in the technical specifications or not.

#### 1.3 REFERENCES

- A. Installation requirements are found in the following standards.
  - 1. ANSI/TIA-568-D Generic Telecommunications Cabling for Customer Premises.
  - 2. ANSI/TIA-569-E Telecommunications Pathways and Spaces
  - 3. ANSI/TIA-606-C Administration Standard for Telecommunication Infrastructure
    - a. The Contractor is required to adhere to the current version of the standards at the time of construction.

#### 1.4 SUBMITTALS

- A. Manufacturer and Contractor Certifications are required submittals in the division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.
- B. Submittal data for cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

#### 1.5 WORK BY OTHERS

- A. In general, the following is provided or is of note:
  - 1. Electrical Contractor will provide field conduit paths for use by the division 27 Contractor.

#### 1.6 FIRESTOPPING

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than "non-rated" shall constitute a wall that requires fire stopping in all penetrations/openings.

### PART 2 - PRODUCTS

#### 2.1 COPPER BACKBONE CABLE AND CONNECTIVITY PRODUCTS

- A. Copper backbone cables shall be the size and type required for the system of intended use.

- B. Copper backbone cable shall be the type specified for use in a plenum, non-plenum, and riser spaces.
- C. Copper backbone cable shall be category 3, 24 AWG, twisted, solid annealed copper conductors. The conductors shall be insulated with PVC and have an overall aluminum shield.
- D. Copper riser cable shall be provided by the Division 27 Contractor.
- E. Acceptable Manufacturers:
  - 1. Superior Essex
  - 2. General Cable
  - 3. Belden
  - 4. Commscope
- F. Additional Cabling and Connectivity Requirements:
  - 1. All copper backbone cables shall be home-run. Cables shall not be spliced.
  - 2. Furnish and install copper backbone cables between telecommunications rooms and or field device locations as noted on the drawings.
  - 3. Provide terminations onto insulation displacement connectors for high pair count copper cables.
  - 4. All copper backbone cable shall be bonded using manufacture's hardware and per the manufacturer's and industry standard's instruction.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION AND LABELING**

- A. Install optical fiber cables and associated hardware as indicated in accordance with manufacturer's written instructions, and recognized industry standards.
  - 1. In general, copper backbone cable shall be installed in the noted existing or newly installed telecommunication primary pathways.
  - 2. All copper backbone cable shall have a minimum 10' service loop at both ends of the cables unless noted otherwise.
  - 3. Copper backbone cable service loops shall be securely installed on the wall in the telecommunication rooms and clear of adjacent utilities or services in the room.
  - 4. Copper backbone cable service loops shall be completely accessible so that they can be extended if required.
  - 5. D rings are allowed in telecommunications room as needed to support and secure copper backbone service loops to the wall.
  - 6. The contractor shall use hook and loop type fasteners on all copper backbone cable. Tie wraps may be temporarily used loosely for dressing copper backbone cables during installation only and shall be removed before final inspection.
  - 7. All tie wraps used in the project shall be trimmed flush at the locking device using a fully flush cutter tool for safety. Any tie wrap found with a sharp point shall be removed by the Contractor and replaced without additional compensation.
- B. Identify all copper backbone cables that terminate in the telecommunication room.
  - 1. Contractor shall provide labels as specified in Section 27 05 53.

- C. After completion, all cables shall be thoroughly tested in accordance with the division 27 Testing and Documentation section.
1. Contractor shall perform a continuity test on all copper backbone cable (pairs) installed on the project.
  2. This test is to confirm there are no open's, short's, or crossed pairs. The Owner representative and or design professional shall be given the opportunity to be present during this testing.

**END OF SECTION 27 11 00**

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## SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. This Section identifies the specification for optical fiber cable.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this optical fiber cabling system in compliance with the specifications and drawings. Contractor will provide and install all the required material to form a complete system whether specifically addressed in the technical specifications or not.

#### 1.3 REFERENCES

- A. Installation requirements are found in the following standards.
  - 1. ANSI/TIA-568-D Generic Telecommunications Cabling for Customer Premises.
  - 2. ANSI/TIA-569-E Telecommunications Pathways and Spaces
  - 3. ANSI/TIA-606-C Administration Standard for Telecommunication Infrastructure
  - 4. ANSI/TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
  - 5. ANSI/TIA-526-14 Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant.
    - a. The Contractor is required to adhere to the current version of the standards at the time of construction.

#### 1.4 SUBMITTALS

- A. Manufacturer and Contractor Certifications are required submittals in the Division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.
- B. Submittal data for cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

#### 1.5 WORK BY OTHERS

- A. In general, the following is provided or is of note:
  - 1. Electrical Contractor will provide field conduit paths for use by the Telecom or other Division 27 Contractor.

#### 1.6 FIRESTOPPING

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than "non-rated" shall constitute a wall that requires fire stopping in all penetrations/openings.

## PART 2 - PRODUCTS

### 2.1 OPTICAL CABLE AND CONNECTIVITY PRODUCTS

- A. Cabling and connectivity products (splice/termination panels, fusion or mechanical field terminated splicing connectors, etc.) must be part of a matched solution, provided by manufacturers that have been tested together and provide a fully certified end to end system.
- B. Acceptable Manufacturers:
1. Optical Fiber:
    - a. Corning FREEDM One Tight-Buffered, Interlocking Armored Cable
      - 1) 12 F, Single-Mode(OS2), Plenum: 012E8P-31131-A3
  2. Fiber Housing: Corning
    - a. Corning Closet Connector Housing (CCH)
      - 1) 1RU, Rack Mountable, Closet Connector Housing, Holds Two CCH Connector Panels and or Splice Cassettes: CCH-01U
      - 2) 4RU, Rack Mountable, Closet Connector Housing, Holds Twelve CCH Connector Panels and or Splice Cassettes: CCH-04U
  3. Fiber Housing Connector Panel: Corning
    - a. Corning Closet Connector Housing (CCH) Panel
      - 1) (LC) Blue Adapter, Duplex, UPC, 12 F, Single-Mode (OS2), Duplex Panel: CCH-CP12-A9
  4. Optical Fiber Field Terminated Connector: Corning
    - a. Corning UniCam Connector
      - 1) (LC) Blue, High-Performance Connector, Single-Mode (OSD): 95-200-99
  5. Optical Fiber Fusion Spliced Connector: Corning
    - a. Corning Closet Connector (CCH) Pigtailed Splice Cassette
      - 1) CCH Pigtailed Splice Cassette, 12 F, LC UPC Duplex, Single-Mode (OS2): CCH-CS12-A9-P00RE
- C. Additional Cabling and Connectivity Requirements:
1. All optical fiber cables shall be home-run. Cables shall not be spliced.
  2. All optical fiber shall be run in 2" orange EMT conduit, provided by Division 26 Contractor. Division 27 13 23 Contractor shall coordinate with Div 26 Contractor in the routing of raceways.
  3. Furnish and install optical fiber between telecommunications room and field device locations as noted on the drawings.
  4. Provide optical fiber terminations at telecommunication rooms and or all field location as noted on the drawings using the note field termination connectors or fusion splice connectors.
  5. All optical fiber connector panels shall be configured with 6 LC duplex adapters to support 12 connectors.
  6. All incoming or outgoing building optical fiber shall be bonded using manufactured hardware and per the manufacturer's instructions.
  7. For powered fiber requirements, reference the Technology Powered Fiber System Schedule.



## **PART 3 - EXECUTION**

### **3.1 INSTALLATION AND LABELING**

- A. Install optical fiber cables and associated hardware as indicated in accordance with manufacturer's written instructions, and recognized industry standards.
1. In general, interior optical fiber shall be installed in the noted existing or newly installed telecommunication primary pathways.
  2. All optical fiber cable shall have a minimum 20' service loop at both ends of the cables unless noted otherwise.
  3. Optical fiber cable service loops, unless note otherwise, shall be securely installed on the wall in the telecommunication rooms and clear of adjacent utilities or services in the room.
  4. Optical fiber cable service loops shall be completely accessible so that they can be extended if required.
  5. D rings are allowed in telecommunications room as needed to support and secure optical service loops to the wall.
  6. The contractor shall use hook and loop type fasteners on all optical fiber cable. Tie wraps may be temporarily used loosely for dressing optical fiber cables during installation only and shall be removed before final inspection.
  7. Tie wraps may be used carefully on armored OSP or in building cabling at light tension levels which do not result in any visible cable jacket deformation.
  8. If unarmored optical fiber cable is specified without innerduct for any reason, tie wraps are prohibited on that cabling.
  9. All tie wraps used in the project shall be trimmed flush at the locking device using a fully flush cutter tool for safety. Any tie wrap found with a sharp point shall be removed by the Contractor and replaced without additional compensation.
- B. Identify all optical fiber cables that terminate in the telecommunication room.
1. Contractor shall provide labels as specified in Section 27 05 53.
- C. After completion, all cables shall be thoroughly tested in accordance with the Division 27 Testing and Documentation section.
1. Contractor shall provide all instruments for testing the optical fiber cables.
  2. Contractor shall demonstrate in the presence of Owner's representative that the optical fiber system is complete and operational.
  3. Contractor shall complete and submit the Certificate of System Demonstration.

**END OF SECTION 27 11 00**

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## SECTION 27 15 33 - COMMUNICATION COAXIAL HORIZONTAL CABLING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Communications General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this cable television system in compliance with the specifications and drawings. Contractor will provide and install all required material to form a complete system whether specifically addressed in the technical specifications or not.

#### 1.3 SUBMITTALS

- A. Manufacturer and Contractor Certifications are required submittals in the Division 27 General Provisions specifications section. The Manufacturer Certification is based on the material information listed below in the Acceptable Manufacturers paragraph.
- B. Submittal data for cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

#### 1.4 WORK BY OTHERS

- A. In general, the following is provided or is of note:
  - 1. Electrical Contractor will provide field device back boxes and conduit paths for use by the Telecom or other Division 27 Contractor.

#### 1.5 FIRESTOPPING

- A. Contractor shall be responsible for fire stopping all conduit sleeves (internally only) and cable tray where required to maintain integrity of fire and/or smoke walls. The Contractor shall review architectural drawings to determine which walls have a fire and/or smoke rating. Any rating other than “non-rated” shall constitute a wall that requires fire stopping in all penetrations/openings.

### PART 2 - PRODUCTS

#### 2.1 CABLE TELEVISION (CATV) CABLING AND AMPLIFICATION

- A. Provide and install CATV horizontal cables, taps and/or splitters, amplifiers (if needed) and field devices as noted on plans.
- B. Acceptable Manufacturers:
  - 1. Coax:
    - a. CommScope 2275V RG6 **Plenum**, Belden and or General Cable equivalent is acceptable

- b. CommScope 2285K RG11 Plenum, Belden and or General Cable equivalent is acceptable.
  2. Compression Style (F) Connectors shall be Belden-Snap-N-Seal, Thomas and Betts or Ideal connectors.
  3. Taps and Splitters shall be Blonder Tongue or approved equal.
  4. Active Headend equipment shall be Blonder Tongue or approved equal.
- C. Additional Requirements:
  1. Cable TV service locations within two hundred ninety-five feet (295') of the service source end, shall be RG6 coax cable.
  2. Cable TV service locations exceeding two hundred ninety-five (295') of the service source end, shall be RG11 coax cable.
  3. Provide and install compression style F connectors at all field locations.
  4. Provide and install compression style F connectors at the source end of the coaxial cabling telecom room or distributed tap locations.
  5. CATV signal strength at each television/tuner location shall be 7dB ± 3dB.
  6. Provide and install Blonder Tongue active amplifier(s) as needed to keep signal strength level within the acceptable 7dB ± 3dB range.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION AND LABELING**

- A. Install horizontal coax cables and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
  1. Additionally, the Contractor shall follow all Execution requirements as stated in Section 27 11 00

**END OF SECTION 27 15 33**

## SECTION 27 45 00 – SOUND MASKING SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The following requirements are applicable to work required of this section:
  - 1. Division 00 – Procurement, Contracting and Warranty Requirements
  - 2. Division 01 - General Requirements
  - 3. Section 26 05 29 – Hangers and Supports for Electrical Systems
  - 4. Section 26 05 33 – Raceways and Boxes for Electrical Systems
  - 5. Section 27 00 10 – Communications General Provisions.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this Sound Masking system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

#### 1.3 SUBMITTALS

- A. Submittal data for Sound Masking cabling and components shall consist of:
  - 1. Catalog cuts showing technical product data necessary to evaluate the materials.
  - 2. Riser Diagram depicting intended signal flow.
  - 3. Floor plan indicating quantity, type, and location of components.

#### 1.4 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes if needed, and conduit paths for use by Contractor.

#### 1.5 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

#### 1.6 ACCEPTABLE SOUND MASKING CONTRACTORS

- A. The contractor shall have the following qualifications:
  - 1. Factory qualified and certified to install products listed in Part 2 – Products
  - 2. Experienced in design, fabrication, installation, checkout, and warranty contract management of sound-masking systems.
  - 3. Versed in the provisions related to sound Masking systems of the following
    - a. NFPA 72
    - b. UL Chapter 24
    - c. American with Disabilities Act (ADA)
    - d. HIPPA (45 CFR, Parts 160 and 164)

- B. The contractor looking for a bid from the contractors listed above shall contact them as soon as possible to ensure they are aware of the project and have adequate time to prepare a bid. Two weeks should be considered a minimum.

## **PART 2 - PRODUCTS**

### **2.1 SOUND MASKING SYSTEMS**

- A. Sound Masking systems shall be provided with all applicable accessories as a system.
- B. Acceptable Manufacturers:
  - 1. Lencore
  - 2. Biamp Cambridge
  - 3. LogiSon
  - 4. Sound Management Group
- C. Additional Sound Masking System Requirements:
  - 1. The Sound Masking system shall be fully installed within manufacturer requirements and suggested guidelines.
  - 2. Adjust levels independently to minimum level between 40 and 50 dBA that will provide speech privacy between adjacent workstations while complying with other system requirements.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install Sound Masking systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
  - 1. Contractor shall use provided raceways or Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.
  - 2. All Sound Masking cabling shall be home-run, no splicing.
- B. Identify all Sound Masking cables as to field location.
  - 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
  - 1. Contractor shall provide all instruments for testing the cables.
  - 2. Contractor shall demonstrate in the presence of Owner's representative that the Sound Masking system is complete and operational.
  - 3. Contractor shall complete and submit the Certificate of System Demonstration.

- D. After completion, comprehensive As-Builts shall be created and provided to the design team for review.
  - 1. Two hard copies shall be provided to Owner detailing the entire Sound Masking system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

### **3.2 COMMISSIONING**

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.
- B. Operation and Maintenance Data:
  - 1. Provide as-built drawings of the system including schematics and floor plans indicating quantity, type, and location of components, cabling, and accessories.
  - 2. Operation and maintenance manuals.
  - 3. Provide warranty documentation, with start date(s) and service contract(s).
  - 4. Software and Firmware Operational Documentation:
    - a. Inventory of system components, with model and serial numbers for each.
    - b. Software operating and upgrade manuals.
    - c. Program Software and System Settings Backup: On digital media complete with data files. Provide electronic backup file of all system settings.
    - d. Device address list.
    - e. Printout of software application and graphic screens.
    - f. Provide login ID and password(s) to access control functions on the graphical user interface, if applicable.

**END OF SECTION 27 45 00**

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## SECTION 27 50 00 – INTERCOM SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Communications General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of an intercom system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

#### 1.3 SUBMITTALS

- A. Submittal data for intercom cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

#### 1.4 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes if needed, and conduit paths for use by Contractor.

#### 1.5 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

#### 1.6 ACCEPTABLE PAGING CONTRACTORS

- A. The contractor shall be one of the following:
  - 1. The Contractor shall be a manufacturer authorized dealer in good standing (for at least six months before project bid date with verifiable documentation) for the products listed below in 2.01.B, ACCEPTABLE MANUFACTURERS.

### PART 2 - PRODUCTS

#### 2.1 INTERCOM SYSTEMS

- A. Intercom systems shall be provided with all applicable accessories as a system.
- B. Acceptable Manufacturers:
  - 1. Window Intercom:
    - a. Norcon Communications: Talk Thru Unit
    - b. Approved Equal

2. SIP Compatible Wall Unit
  - a. Aiphone
  - b. Viking
  - c. Approved Equal

C. Additional Paging System Requirements:

1. Intercom field units must meet or include attachment to meet ADA requirements.
2. Intercom field units must meet minimum standards for a detention facility.

**2.2 INTERCOM SYSTEMS EQUIPMENT**

A. Intercom systems shall be provided with all applicable accessories as a system.

HARDWARE	PART #
<i>Window or Desk Mounted Station</i>	<b>Norcon:</b> TTU-1AX
<i>SIP Compatible Wall Station</i>	<b>Aiphone:</b> IX-SS-2G <b>Viking:</b> E-32TF-IP

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. Install Paging systems cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.

1. Contractor shall use hook and loop type fasteners on all paging cable. Tie wraps shall not be used.
2. Contractor shall use provided raceways or Contractor install J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.
3. All paging cabling shall be homerun, no splicing.

B. Identify all paging cables as to field location.

1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.

C. After completion, all cables shall be thoroughly tested.

1. Contractor shall provide all instruments for testing the cables.
2. Contractor shall demonstrate in the presence of Owner's representative that the intercom system is complete and operational.
3. Contractor shall complete and submit the Certificate of System Demonstration.

D. After completion, comprehensive As-Builts will be created and provided to Owner within 3 days.

1. Two hard copies shall be provided to Owner detailing the entire paging system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

### **3.2 COMMISSIONING**

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

**END OF SECTION 27 50 00**

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## SECTION 27 51 29 – EMERGENCY COMMUNICATION SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 27 00 10 – Communications General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this IP-enabled Digital Area of Refuge/Area of Rescue Assistance Signal System designed ADA (Americans with requirements. This work shall include a main control panel, optional remote-control panels, an internal modem, optional proprietary field switches for systems over 8 zones, remote call stations, power supply(s), outlet boxes, cables and wiring as shown on the drawings and as specified herein.

#### 1.3 SUBMITTALS

- A. Submittal data for communication system cabling and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.
- B. Submit shop drawings showing layout, profiles, and product components, including anchorage and accessories. Include cabling diagrams, wiring diagrams, station installation details, and equipment cabinet details.
- C. Submit certified test reports showing compliance with specified performance characteristics.

#### 1.4 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

#### 1.5 ACCEPTABLE EMERGENCY COMMUNICATION SYSTEM CONTRACTORS

- A. The contractor shall be a factory trained authorized dealers/distributors, in accordance with ANSI/NFPA 70 National Electrical Code. and NFPA 72 Fire Alarm Code.in good standing (for at least six months before project bid date with verifiable documentation) for the products listed below in 2.01.B, Acceptable Manufacturers.
- B. Properly trained personnel, familiar with Telecommunications Industry Associations 568 TIA/EIA standard, are required for proper installation. Failure to terminate the wiring correctly will cause damage to the system and void the warranty.

### PART 2 - PRODUCTS

#### 2.1 IP-ENABLED EMERGENCY COMMUNICATION SYSTEM

- A. Emergency communication system shall be provided with all applicable accessories as a system.

- B. Acceptable Manufacturers:
1. Cornell Communications Inc,
  2. Code Blue Corporation
  3. Talkaphone, LLC
  4. Rath Communications
- C. Product Substitutions:
1. No substitutions permitted.
- D. System Components:
1. Main Control Panel
    - a. Remote Panels as required.
  2. Call Station
    - a. Multiple Call Stations as required.
  3. Battery Backup
  4. Signage
- E. Additional Requirements:
1. Division 27 shall provide a fully supervised, two-way voice communication system between each call station and the main control panel capable of external alarm notification and two-way voice communication to a 24/7 emergency monitoring service.
  2. The system shall be full duplex VoIP using SIP standards.
  3. System shall include a dialer connected to POTS telephone line (outside dial tone) for forwarding calls that are not answered by a first responder at the main panel.
  4. System shall include an IP analog telephone adaptor (ATA) for external alarm notification and two-way voice communication. Coordinate with the Client for necessary network information to program the ATA.
  5. The system shall poll (supervise) all the call stations, control panels and field switches on a continuous basis at least every 200 seconds to identify line faults and defective equipment. Faults will be alerted and displayed at the control panel(s).
  6. Division 27 shall provide 24/7/365 electrical power to the system. The system shall not need or accept a fire alarm system activation signal to be operational; it shall always be operational no matter the status of the fire alarm system.
  7. Division 27 shall provide the electrical contractor any proprietary back boxes at least two weeks before rough-in time.
  8. To program the main control panel for external communication. Division 27 shall initiate and coordinate available phone numbers and or SIP information with the Client for programming.
  9. Division 27 shall provide code required signage on the wall at every call station installed on the project.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install the emergency communication system cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
  - 1. Contractor shall install cabling in conduit provided by Division 26.
  - 2. All emergency communication signal system cabling shall be homerun, no splicing and in accordance with the manufacturers' wiring diagrams.
  - 3. All wiring shall test free from grounds and shorts.
- B. Identify all emergency communication signal system cables as to field location.
  - 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, the system shall be thoroughly tested.
  - 1. Contractor shall demonstrate in the presence of Owner's representative that the emergency two-way communication signal system is complete and operational.
  - 2. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to Owner within 10 days.
  - 1. Two hard copies shall be provided to Owner detailing the entire emergency two-way communication signal system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

### **3.2 COMMISSIONING**

- A. The contractor shall initiate and coordinate a time with the Client and Engineer for a complete system demonstration after final installation. The demonstration shall include end-to-end two-way communication from all area-of-rescue call stations to the master call station and the remote monitoring agency. A return call from the monitoring agency to the area-of-rescue call stations will be a part of the demonstration.
  - 1. Notify the monitoring agency or local law enforcement and emergency responders that are a part of the emergency call plan at a minimum of 48 hours before the demonstration.

**END OF SECTION 27 51 29**

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## SECTION 27 60 00 - CLOCK SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements, Section 27 00 10 – Communications General Provisions, and Section 27 11 00 – Communications Cabling and Equipment are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this clock system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

#### 1.3 SUBMITTALS

- A. Submittal data for clock system and components shall consist of catalog cuts showing technical data necessary to evaluate the materials.

#### 1.4 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes, and conduit paths for use by Contractor, if applicable.

#### 1.5 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire walls. Contractor shall see architectural drawings for walls that require fire rating.

#### 1.6 ACCEPTABLE CLOCK SYSTEM CONTRACTOR

- A. The contractor shall be a factory authorized manufacturer dealer, verifiable by the regional manufacturer's representative.
- B. Acceptable Manufacturers:
  - 1. Sapling
  - 2. Primex
  - 3. American Time
- C. The contractor looking for a bid from the contractors listed above shall contact them as soon as possible to ensure they are aware of the project and have adequate time to prepare a bid. Two weeks should be considered a minimum.

## **PART 2 - PRODUCTS**

### **2.1 CLOCK SYSTEM**

- A. The clock system shall be provided with all applicable accessories as an IP PoE system with wireless transmission capabilities.
- B. Acceptable Components:
  - 1. Master Clock
    - a. Software components for PoE system shall include:
      - 1) Naming updates for clocks.
      - 2) MAC Address.
      - 3) Time zone options.
      - 4) Synchronization status.
      - 5) Brightness scheduling on digital LED displays.
      - 6) 10 NTP time source options.
      - 7) 12 / 24 display options
      - 8) PC - Windows based software.
    - b. The software shall have no re-occurring software fees, maintenance fees or tech support fees.
  - 2. Wireless Clocks with a built-in repeater.
    - a. 12.5" Analog Single-Face, Black Frame
    - b. 12.5" Analog Dual-Face, Black Frame
    - c. Digital, Black Frame with Red Display
  - 3. Wired Clocks (PoE)
    - a. Analog Single-Face, Black Frame
- C. Additional Clock System Requirements:
  - 1. All devices in exercise designated areas shall have wire guards.
  - 2. The Contractor shall not add or include their or any other company name or logo the clock face. The Manufacturers name/logo which comes complete with each clock is the only thing acceptable on the clock unless the Owner chooses to add their name or logo (still no contractor name or logo will be allowed). Clocks not conforming to this requirement shall be fully replaced at the Contractors expense.
  - 3. Provide and install per additional requirements found on the plans.
  - 4. System must contain a master clock with transmitter capabilities to bridge an IP PoE system and wireless clocks.
  - 5. Connect to network time service via NTP.
  - 6. Clock system must integrate with emergency services components.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install clock system cables, equipment, and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
  - 1. Contractor shall use hook and loop type fasteners on all cable. Tie wraps shall not be used.

2. Contractor shall use provided raceways or Contractor installed J-hooks for all cabling. No fastening cabling to conduits, piping, equipment, or anything other than Contractor installed J-hooks.
- B. Integrate clock system with Owner's electrical and communications network.
  - C. Contractor to coordinate PoE activation for Emergency Services with Owner.
  - D. Identify all system cables as to field location.
    1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
  - E. E. Install clocks only after painting and other finish work is completed in each room.
  - F. After completion, all cables shall be thoroughly tested.
    1. Contractor shall provide all instruments for testing the cables.
    2. Contractor shall demonstrate in the presence of Owner's representative that the clock system is complete and operational.
    3. Contractor shall complete and submit the Certificate of System Demonstration.
  - G. After completion, comprehensive As-Builts will be created and provided to Owner within 3 days.
    1. Two hard copies shall be provided to Owner detailing the entire clock system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

### **3.2 COMMISSIONING**

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

**END OF SECTION 27 60 00**

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**DIVISION 28**



## SECTION 28 00 10 - ELECTRONIC SAFETY AND SECURITY GENERAL PROVISIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Refer to Division 00 - Procurement and Contracting Requirements and Division 01 - General Requirements, which all apply to work under this section.

#### 1.2 DESCRIPTION OF WORK

- A. This section applies to all work under this division. This shall include, but not necessarily be limited to, the following:
  - 1. Furnish, install, and terminate all system equipment and cabling as applicable and per drawings.
  - 2. Furnish and install any cabinets, racks, and cable management as required and as indicated.
  - 3. Furnish any other material required to form a complete and operational system.
  - 4. Provide As-Built drawings per Division 0 and/or Division 1 specification.
  - 5. Provide Owner training and testing documentation.
  - 6. All elements of the construction shall be performed by workmen skilled in the particular craft involved, and regularly employed in that particular craft.
  - 7. All work shall be performed in a neat, professional manner in keeping with the highest standards of the craft.

#### 1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
  - 1. National Electrical Code
  - 2. Local Electrical Code
  - 3. National Fire Protection Association
  - 4. National Electrical Manufacturers Association
  - 5. Standards of Institute of Electrical and Electronic Engineers
  - 6. Applicable Building Codes
  - 7. Occupational Safety and Health Act
  - 8. Wisconsin Administrative Codes
  - 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
  - 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
  - 11. ANSI TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
  - 12. ANSI TIA-568-C.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
  - 13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
  - 14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
  - 15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
  - 16. ANSI TIA-569-D Telecommunications Pathways and Spaces
  - 17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
  - 18. ANSI TIA-598-D Optical Fiber Cable Color Coding
  - 19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure

20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

B. All Contractors shall familiarize themselves with all codes and standards applicable to their work. No extra compensation will be allowed for corrections or changes in the work required due to failure to comply with the applicable codes and standards. Where two or more codes or standards are in conflict, that requiring the highest order of professionalism shall take precedence, but such questions shall be referred to Design Professional for final decision.

#### **1.4 REQUIREMENTS & FEES OF REGULATORY AGENCIES**

A. Contractor shall comply with the rules and regulations of the local serving utility companies and shall check with each utility company providing service to this project and determine or verify their requirements regarding incoming services.

B. Secure and pay for all permits, licenses, fees, and inspections.

#### **1.5 DRAWINGS**

A. Drawings for the work are in part diagrammatic, and are intended to convey the scope of the work and to indicate in general the location of equipment.

B. Contractor shall layout their own work and shall be responsible for determining the exact quantities and locations for equipment.

C. Contractor shall take own field measurements for verifying locations and dimensions; scaling of the drawings will not be sufficient for laying out the work.

D. Because of the scale of the drawings, certain basic items for a complete installation are not shown, but where such items are required by code or where they are required for proper installation and operation of the work, such items shall be furnished and installed.

#### **1.6 ACTIVE SERVICES**

A. Contractor shall be responsible for verifying exact locations of all existing services prior to beginning work in that area.

B. When active services are encountered which require relocation, Contractor shall make request to authorities with jurisdiction for determination of procedures.

C. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the authorities having jurisdiction.

#### **1.7 SITE INSPECTION**

A. Contractor shall inspect the site prior to submitting bid for work to become familiar with the conditions of the site which will affect the work and shall verify points of connection with utilities and/or existing system wiring.

B. Extra payment will not be allowed for changes in the work required because of Contractor's failure to make this inspection.



## **1.8 COORDINATION AND COOPERATION**

- A. It shall be the Contractor's responsibility to schedule and coordinate work with the schedule of the General Contractor so as to progress the work expeditiously, and to avoid unnecessary delays.
- B. Contractor shall fully examine the drawings and specifications for other trades and shall coordinate the installation of their work with the work of the other contractors. Contractor shall consult and cooperate with the other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to their equipment, other equipment and the building. The Design Professional reserves the right to determine space priority of the contractors in the event of interference between piping, conduit, ducts and equipment of the various contractors.
- C. Conflicts between the drawings and the specifications, or between the requirements set forth for the various divisions shall be called to the attention of the Design Professional. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the Contractor is in agreement with the drawings and specifications as issued. If clarification is required after the contract is awarded, such clarification will be made by the Design Professional and the decision will be final.
- D. Special care shall be taken for protection for all equipment. All equipment and material shall be completely protected from weather elements, painting, plaster, etc., until the project is substantially completed. Damage from rust, paint, scratches, etc., shall be repaired as required to restore equipment to original condition.
- E. Protection of all equipment during the painting of the building shall be the responsibility of the Painting Contractor, but this shall not relieve the Contractor of the responsibility for checking to assure that adequate protection is being provided.
- F. Where the final installation or connection of equipment in the building requires the Contractor to work in areas previously finished by the Owner, the Contractor shall be responsible that such areas are protected and are not marred, soiled or otherwise damaged during the course of such work. Contractor shall be responsible for patching and refinishing of such areas which may be damaged in this respect.
- G. Where two or more specified items/systems in the specifications and/or the drawings are in conflict, that requiring the highest order of professionalism and the most financially expensive products shall take precedence. Such questions shall be referred to the Design Professional for final decision.

## **1.9 MATERIALS AND EQUIPMENT**

- A. All materials and equipment shall be the standard product of a reputable manufacturer regularly engaged in the manufacture of the specified item unless authorized in writing by Design Professional. Where more than one unit is required of the same items, they shall be furnished by the same manufacturer except where specified otherwise.
- B. All material and equipment shall be installed in strict accordance with the manufacturer's recommendations.
- C. The equipment specifications cannot deal individually with any minute items such as parts, controls, devices, etc., which may be required to produce the equipment performance and function as specified, or as required to meet the equipment guarantees. Such items when required shall be furnished as part of the equipment, whether or not specifically called for.

**1.10 SUBMITTALS**

- A. Contractor shall furnish, to the Design Professional, complete sets of shop drawings and other submittal data. Contractor shall review and sign shop drawings before submittal. Refer to Division 01 specifications for additional requirements.
- B. Shop drawings shall be bound into sets and cover related items for a complete system as much as practical and shall be identified with symbols or "plan marks" used on drawings. Incomplete, piecemeal or unbound submittals will be rejected.
- C. The Design Professional will review shop drawings solely to assist contractors in correctly interpreting the plans and specifications.
- D. Contract requirements cannot be changed by shop drawings which differ from contract drawings and specifications.
- E. Submittals required by the various sections of the Project Manual include, but are not necessarily limited to those identified in the submittal schedule below.
- F. After award of contract, the contractor shall provide a completed submittal schedule including dates that the submittals will be to the Design Professional for review.
- G. Submit required information on the following items:

SPEC SECTION	EQUIPMENT	DETAIL DWGS	PROD DATA	SAMPLES	INSTALL METHODS	O & M MANUAL	CERTIFICATE OF SYSTEM DEMONSTRATION	OTHER (SEE NOTES)
28 31 00	Fire Alarm and Detection Systems	X	X		X	X	X	
28 50 00	Access Control		X			X	X	
28 60 00	Video Surveillance System		X			X	X	
28 80 00	Distributed Antenna System		X			X	X	

Notes:

**1.11 OPERATION AND MAINTENANCE MANUALS**

- A. Operation and maintenance manuals shall be submitted to the Design Professional in duplicate upon completion of the job. Refer to Division 01 specifications for additional information.
- B. Submit manuals in duplicate upon completion of the job. Manuals shall be bound in a three-ring hard backed binder. Front cover and spine of each binder shall have the following lettering done:

OPERATION  
AND  
MAINTENANCE  
MANUAL  
FOR  
TELECOMMUNICATIONS SYSTEMS

(PROJECT NAME)  
(LOCATION)  
(DATE)

SUBMITTED BY  
(NAME, ADDRESS AND PHONE NUMBER OF CONTRACTOR)

- C. Provide a master index at the beginning of manual showing items included. Each section shall contain the following information for equipment furnished under this contract:
1. Equipment and system warranties and guarantees.
  2. Installation instructions.
  3. Operating instructions.
  4. Maintenance instructions.
  5. Spare parts identification and ordering list.
  6. Local service organization, address, contact and phone number.
  7. Shop drawings with reviewed stamp of Design Professional and Contractor shall be included, if applicable, along with the items listed above.

**1.12 TESTS AND DEMONSTRATIONS**

- A. All systems shall be tested by the Contractor and placed in proper working order prior to demonstrating systems to Owner.

**1.13 TRAINING AND DEMONSTRATIONS**

- A. Prior to acceptance of the telecommunications installation, the Contractor shall provide to the Owner, or their designated representatives, all comprehensive training on essential features and functions of all systems installed, and shall instruct the Owner in the proper operation and maintenance of such systems.

1. Provide adequate notice to the Owner as to when instruction will be conducted so appropriate personnel can be present.
2. Prepare the instruction format for a minimum of four Owner Representatives.

- B. Equipment training:

1. Manufacturer's representatives shall provide instruction on each major piece of equipment. The Contractor shall provide instruction on all other equipment.
2. Training sessions shall use the printed installation, operation and maintenance instruction materials included in the O&M manuals and emphasize preventative maintenance and safe operating procedures.
3. Training shall be performed by qualified factory trained technicians.
4. The Contractor shall attend all sessions performed by the manufacturer's representative and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
5. Equipment training shall occur as soon as possible after start up of the equipment and shall include hands-on operation. Training shall be provided for equipment listed in the table below.

- C. System training:

1. Training sessions shall include hands-on demonstrations of system wide start-up, operation in all possible modes, shut-down and emergency procedures.

- D. The following are minimum requirements for Owner instruction:

Section	Description	Hrs. on Site	Hrs. off Site	Presented By	Others Present	Remarks
28 3100	Fire Alarm and Detection Systems	4	0	Manufacturer's Representative	Contractor	1
28 5000	Access Control	4	0	Access Control Contractor	Owner	1

<b>Section</b>	<b>Description</b>	<b>Hrs. on Site</b>	<b>Hrs. off Site</b>	<b>Presented By</b>	<b>Others Present</b>	<b>Remarks</b>
28 6000	Video Surveillance	4	0	Video Surveillance Contractor	Owner	1
28 7000	Intrusion Detection System	4	0	Intrusion Detection Contractor	Owner	1
28 8000	Distributed Antenna System	2	0	DAS Contractor	Owner	1
Remarks:						
1. Perform complete system test at time of instruction.						

- E. The Contractor shall submit a certificate, signed by the Owner stating the date, time and persons instructed and that the instruction has been completed to the Owner's satisfaction. An example of a certificate form is as follows:

## CERTIFICATE OF SYSTEM DEMONSTRATION

This document is to certify that the contractor has demonstrated the hereafter listed systems to the Owner's representatives in accordance with the Contract documents and that the instruction has been completed to the Owner's satisfaction.

- A. Project:
- B. System(s):
- C. Contractor's representatives giving instruction and demonstration:

Contractor: \_\_\_\_\_

NAMES	DATE	HOURS

- D. Owner's representatives receiving instruction:

Owner: \_\_\_\_\_

NAMES	DATE	HOURS

- E. Acknowledgement of demonstration:

Contractor's Representative:

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Owner's Representative:

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

#### **1.14 PERMITS, FEES, ETC.**

- A. Secure all required permits and pay for all inspections required in connection with the electronic safety and security systems work. Contractor shall post all bonds and obtain all licenses required by the State, City, County, and Federal Agencies.

#### **1.15 SUBSTITUTIONS**

- A. To obtain approval to use unspecified equipment, Bidding Contractors (not equipment supplier, manufacturers, etc.) shall submit written requests to the Design Professional at least 10 days prior to bid due date. Requests shall clearly describe the equipment for which approval is being requested. Include all data necessary to demonstrate that equipment's capacities, features and performance are equivalent to include a cost comparison between specified equipment and equipment for which approval is being requested. If the equipment is acceptable, the Design Professional will approve it in an addendum. The Design Professional will, under no circumstances, be required to prove that an item proposed for substitution is or is not of equal quality to the specified item.
- B. Where substitutions are approved, Contractor assumes all responsibility for physical dimensions and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of the substitution.

#### **1.16 APPROVED CONTRACTORS**

- A. The Contractor shall be a manufacturer certified installer and service provider for the product submitted and installed. A copy of the Contractor's manufacturer certification must be submitted under this specification section for the Access Control Contractor and the Video Surveillance Contractor if applicable to the project. The Contractor is responsible for professional and installation practices in accordance with the manufacturer requirements and must be authorized to provide a Manufacturer's Product Warranty with their installation.
- B. The Contractor pulling the cabling (if different from the prime system Contractor) shall meet the BICSI or IBEW/NECA requirements found in the Division 27 General Provisions.
- C. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

#### **1.17 ACCEPTABLE MANUFACTURERS**

- A. In most cases, equipment specifications are based on a specific manufacturer's type, style, dimensional data, catalog number, etc. Listed with the base specification, either in the manual or on the plans are acceptable manufacturers approved to bid products of equal quality. These manufacturers are encouraged to submit to the Design Professional at least 8 days prior to the bid due date drawings and catalog numbers of products to be bid as equals.
- B. Manufacturers who do not submit prior to bidding run the risk of having the product rejected at time of shop drawing submittal. Extra costs associated with replacing the rejected product shall be the responsibility of the Contractor and/or the manufacturer.

- C. If the Contractor chooses to use a manufacturer listed as an equal, it shall be their responsibility to assure that the manufacturer has complied with the requirements in 'A' above. Contractor shall assume all responsibility for physical dimensions, operating characteristics, and all other resulting changes. This responsibility extends to cover all extra work necessitated by other trades as a result of using the alternate manufacturer.
- D. Where a model or catalog number is provided, it may not be inclusive of all product requirements. Refer to additional requirements provided on the plans or in the specifications as required. Similarly, there may be additional requirements included in the model or catalog number that are not specifically stated. These requirements shall also be met.

#### **1.18 QUALITY ASSURANCE**

- A. The Contractor shall be a company specializing in telecommunication cable and/or accessories with a minimum of five years documented experience in installation of cable and/or accessories similar to those specified below.

#### **1.19 WARRANTY**

- A. Refer to Divisions 00 and 01 for information on warranties and correction of work within the warranty period.
  - 1. If a warranty or warranty period are not defined in Division 00 or 01, then the start of all warranty periods shall be the date of Substantial Completion and the length of the warranty shall be for one year.
    - a. If construction is phased with distinct and separate Substantial Completion dates for portions of the building and/or systems, separate warranties shall be provided for each of these phased areas and/or systems.
    - b. All Division 28 systems, including all sub-systems, shall be guaranteed against defect in materials and installation for the duration of the warranty period. Any malfunctions or defects which occur within the warranty period shall be promptly corrected without cost to the Owner. This guarantee shall not limit or void any manufacturer's express or implied warranty.
- B. Refer to other Division 28 sections for systems, equipment, or material requiring extended warranties.
- C. The date of systems/equipment startup or equipment/material shipment to the site shall not be considered the notable date with relation to the warranty of that item. All systems, equipment, material, etc., shall have the same start date with respect to the warranty period.
- D. Systems, equipment or material put into use to facilitate construction activities (e.g. testing and balancing, commissioning, temporary conditioning, etc.) prior to the start of the warranty period shall not impact the length of the warranty in any way.

#### **1.20 CHANGES IN THE WORK**

- A. A Contract Change Order is a written order to the Contractor signed by the Owner and Contractor, issued after the execution of the Contract, authorizing a change in the Work or an adjustment in the Contract Sum or the Contract Time. The Contract Sum and the Contract Time may be changed only by Contract Change Order.

- B. The Owner, without invalidating the Contract, may order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with the Contract Sum and the Contract Time being adjusted accordingly. All such changes in the Work shall be authorized by Contract Change Order and shall be performed under the applicable conditions of the Contract Documents.
- C. The cost or credit to the Owner resulting from a change in the Work shall be determined by mutual acceptance of a lump sum properly itemized and supported by sufficient substantial data to permit evaluation. Change Orders shall be submitted with each item listed individually with a material cost and labor unit extension. Overhead and profit, as mutually agreed upon between Owner and Contractor shall be added to material and labor cost figures.
- D. It shall be the responsibility of the Contractor before proceeding with any change to satisfy themselves that the change has been properly authorized on behalf of the Owner.

**1.21 COMPLETION**

- A. Systems, at time of completion, shall be complete, efficiently operating, non-hazardous and ready for normal use by the Owner.
- B. When all the work is complete the Contractor shall thoroughly clean all material and equipment installed as a part of this contract and leave all equipment and material in new condition.
- C. The Contractor shall clean up and remove from the site all debris, excess material and equipment left during the progress of this contract at job completion.

**END OF SECTION 28 00 10**



**SECTION 28 26 00**  
**ELECTRONIC PERSONAL PROTECTION SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Provide and install complete Duress-Panic Alarms, Emergency Phones/ Call-Boxes, and Intercom Systems, data transmission wiring and a control station with its associated equipment, hereafter referred to as EPPS System.
- B. EPPS shall be integrated with monitoring and control system specified in Division 28 Section [VIDEO SURVEILLANCE SYSTEMS] [INTRUSION DETECTION] [PHYSICAL ACCESS CONTROL SYSTEM] that specifies systems integration.

**1.2 RELATED WORK**

- A. Section 01 00 00 - GENERAL REQUIREMENTS. For General Requirements.
- B. Section 07 84 00 - FIRESTOPPING. Requirements for firestopping application and use.
- C. Section 10 14 00 - SIGNAGE. Requirements for labeling and signs.
- D. Section 14 21 00 - ELECTRIC TRACTION ELEVATORS. Requirements for elevators.
- E. Section 14 24 00 - HYDRAULIC ELEVATORS. Requirements for elevators.
- F. Section 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL INSTALLATIONS. Requirements for connection of high voltage.
- G. Section 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Requirements for power cables.
- H. Section 26 05 33 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS. Requirements for infrastructure.
- I. Section 28 50 00 - ACCESS CONTROL SYSTEM. Requirements for control and operation of all security systems.
- J. Section 28 60 00 - VIDEO SURVEILLANCE. Requirements for security camera systems.

**1.3 1.3 QUALITY ASSURANCE**

- A. The Contractor shall be responsible for providing, installing, and the operation of the EPPS System as shown. The Contractor shall also provide certification as required.
- B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.
- C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

- D. **Manufacturers Qualifications:** The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- E. **Product Qualification:**
1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- F. **Contractor Qualification:**
1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the Security Management System's (PACS) manufacturer. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system. The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the PACS. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility. The facility shall be located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures. The COTR reserves the option of surveying the company's facility to verify the service inventory and presence of a local service organization.
  2. The Contractor shall provide proof project superintendent with BICSI Certified Commercial Installer Level 1, Level 2, or Technician to provide oversight of the project.
  3. Cable installer must have on staff a Registered Communication Distribution Designer (RCDD) certified by Building Industry Consulting Service International. The staff member shall provide consistent oversight of the project cabling throughout design, layout, installation, termination and testing.
- G. **Service Qualifications:** There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within // four // eight // hours of receipt of notification that service is needed. Submit name and address of service organizations.

#### **1.4 SUBMITALS**

- A. Submit below items in accordance with Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY and Master Specification Sections 01 33 23, SHOP DRAWING, PRODUCT DATA, AND SAMPLES, and Section 02 41 00, DEMOLITION.

- B. Provide certificates of compliance with Section 1.3, Quality Assurance.
- C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.
- D. Shop drawings and as-built packages shall include, but not be limited to:
  - 1. Index Sheet that shall:
    - a. Define each page of the design package to include facility name, building name, floor, and sheet number.
    - b. Provide a list of all security abbreviations and symbols.
    - c. Reference all general notes that are utilized within the design package.
    - d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
      - 1) Outline all general and job specific work required within the design package.
      - 2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
  - 2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
    - a. Include a title block as defined above.
    - b. Define the drawings scale in both standard and metric measurements.
    - c. Provide device identification and location.
    - d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
    - e. Identify all pull box and conduit locations, sizes, and fill capacities.
    - f. Address all general and drawing specific notes for a particular drawing sheet.
  - 3. A riser drawing for each applicable security subsystem shall:
    - a. Indicate the sequence of operation.
    - b. Relationship of integrated components on one diagram.
    - c. Include the number, size, identification, and maximum lengths of interconnecting wires.
    - d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
  - 4. A system drawing for each applicable security system shall:
    - a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
    - b. Provide full detail of all system components wiring from point-to-point.
    - c. Identify wire types utilized for connection, interconnection with associate security subsystems.
    - d. Show device locations that correspond to the floor plans.
    - e. All general and drawing specific notes shall be included with the system drawings.
  - 5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
    - a. Device ID.
    - b. Device Location (e.g. site, building, floor, room number, location, and description).
    - c. Mounting type (e.g. flush, wall, surface, etc.).
    - d. Power supply or circuit breaker and power panel number.

6. Detail and elevation drawings for all devices that define how they were installed and mounted.
- E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
    1. 35 percent
    2. 65 percent
    3. 90 percent
    4. 100 percent
  - F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.
  - G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI):
  - ANSI S3.2-09 Method for measuring the Intelligibility of Speech over Communications Systems
- C. Department of Justice American Disability Act (ADA)
  - 28 CFR Part 36 2010 ADA Standards for Accessible Design
- D. Federal Communications Commission (FCC):
  - (47 CFR 15) Part 15 Limitations on the Use of Wireless Equipment/Systems
- E. National Fire Protection Association (NFPA):
  - 70-11 National Electrical Code
- F. National Electrical Manufacturers Association (NEMA)
  - 250-08 Enclosures for Electrical Equipment (1000 Volts Maximum)
- G. Underwriters Laboratories, Inc. (UL):
  - 305-08 Standard for Panic Hardware
  - 444-08 Safety Communications Cables
  - 636-01 Standard for Holdup Alarm Units and Systems

H. Uniform Federal Accessibility Standards (UFAS), 1984

## **1.6 COORDINATION**

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed.

## **1.7 MAINTENANCE & SERVICE**

A. General Requirements

1. The Contractor shall provide all services required and equipment necessary to maintain the entire integrated electronic security system in an operational state as specified for a period of one (1) year after formal written acceptance of the system. The Contractor shall provide all necessary material required for performing scheduled adjustments or other non-scheduled work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other non-scheduled work. See also General Project Requirements.

B. Description of Work

1. The adjustment and repair of the security system includes all software updates, panel firmware, and the following new items computers equipment, communications transmission equipment and data transmission media (DTM), local processors, security system sensors, facility interface, and signal transmission equipment.

C. Personnel

1. Service personnel shall be certified in the maintenance and repair of the selected type of equipment and qualified to accomplish all work promptly and satisfactorily. The COTR shall be advised in writing of the name of the designated service representative, and of any change in personnel. The COTR shall be provided copies of system manufacturer certification for the designated service representative.

D. Schedule of Work

1. The work shall be performed during regular working ours, Monday through Friday, excluding federal holidays. These inspections shall include:
  - a. The Contractor shall perform two (2) minor inspections at six (6) month intervals or more if required by the manufacturer, and two (2) major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
    - 1) Minor Inspections shall include visual checks and operational tests of all console equipment, peripheral equipment, local processors, sensors, electrical and mechanical controls, and adjustments on printers.
    - 2) Major Inspections shall include all work described for Minor Inspections and the following: clean all system equipment and local processors including interior and exterior surfaces; perform diagnostics on all equipment; operational tests of the CPU, switcher, peripheral equipment, check and calibrate each sensor; run all system software diagnostics and correct all problems; and resolve any previous outstanding problems.

E. Emergency Service

1. The owner shall initiate service calls whenever the system is not functioning properly. The Contractor shall provide the Owner with an emergency service center telephone number. The emergency service center shall be staffed 24 hours a day 365 days a year. The Owner shall have sole authority for determining catastrophic and non-catastrophic system failures within parameters stated in General Project Requirements.
  - a. For catastrophic system failures, the Contractor shall provide same day four (4) hour service response with a defect correction time not to exceed eight (8) hours from [notification] [arrival on site]. Catastrophic system failures are defined as any system failure that the Owner determines will place the facility(s) at increased risk.
  - b. For non-catastrophic failures, the Contractor within eight (8) hours with a defect correction time not to exceed 24 hours from notification.

F. Operation

1. Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the applicable portions of the performance verification test.

G. Records & Logs

1. The Contractor shall maintain records and logs of each task and organize cumulative records for each component and for the complete system chronologically. A continuous log shall be submitted for all devices. The log shall contain all initial settings, calibration, repair, and programming data. Complete logs shall be maintained and available for inspection on site, demonstrating planned and systematic adjustments and repairs have been accomplished for the system.

H. Work Request

1. The Contractor shall separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. The Contractor shall deliver a record of the work performed within five (5) working days after the work was completed.

I. System Modifications

1. The Contractor shall make any recommendations for system modification in writing to the COTR. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the COTR. Any modifications made to the system shall be incorporated into the operation and maintenance manuals and other documentation affected.

J. Software

1. The Contractor shall provide all software updates when approved by the Owner from the manufacturer during the installation and 12-month warranty period and verify operation of the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and incorporated into the operations and maintenance manuals and software documentation. There shall be at least one (1) scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the Manufacturer's software. All software changes shall be recorded in a log maintained in the unit control room. An electronic copy of the software update shall be maintained within the log. At a minimum, the contractor shall provide a description of the modification, when the modification occurred, and name and contact information of the individual performing the modification. The log shall be maintained in a white 3 ring binder and the cover marked "SOFTWARE CHANGE LOG".

**1.8 WARRANTY OF CONSTRUCTION.**

- A. Warrant EPPS System work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.
- B. Demonstration and training shall be performed prior to system acceptance.

**1.9 GENERAL REQUIREMENTS**

- A. For general requirements that are common to more than one section in Division 28 refer to Section 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.
- B. General requirements applicable to this section include:
  1. Performance Requirements,
  2. Delivery, Handling and Storage,
  3. Project Conditions,
  4. Equipment and Materials,
  5. Electrical Power,
  6. Lightning, Power Surge Suppression, and Grounding,
  7. Electronic Components,
  8. Substitute Materials and Equipment, and
  9. Like Items.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT AND MATERIALS**

#### **A. General:**

1. All equipment shall be rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.
2. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 hertz (Hz) or 60 Hz Alternating Current (AC) power system unless documented otherwise in subsequent sections listed within this spec. All equipment shall have a battery back-up source of power that will provide 12 hours (hrs.) of run time in the event of a loss of primary power to the security systems until a backup generator comes on-line.
3. The EPPS systems shall be designed, installed, and programmed in a manner that will allow for easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.
4. All EPPS components located in designated "HAZARDOUS ENVIRONMENT" areas where fire or explosion could occur due to the presence of natural gases or vapors, flammable liquids, combustible residue, or ignitable fibers or debris, shall be rated Class II, Division I, Group F, and installed in accordance with National Fire Protection Association (NFPA) 70, National Electrical Code Chapter 5.
5. The Contractor shall provide the Contracting Officer with written verification, that the type of wire/cable being provided is recommended and approved by the OEM. Cabling shall meet the interconnecting wiring requirements of NFPA 70, National Electrical Code. The Contractor is responsible for providing the correct protection cable duct and/or conduit and wiring.
6. When interfacing with other communications or security subsystems the Contractor shall utilize interfacing methods that are approved by the Contracting Officer. At a minimum, an acceptable interfacing method requires not only a physical and mechanical connection; but also a matching of signal, voltage, and processing levels with regard to signal quality and impedance. The interface point must adhere to all standards described herein.
7. Systems shall be scaleable, not vendor specific, and allow expansion as required.
8. Wireless systems shall use ultrasonic, infrared and radio frequency waves to link distributed transmitters and receivers. Specific characteristics of particular facility will determine best application. Contractor is responsible for determining best system using prediction program to determine where readable signals can be obtained and identify "dead spots".
9. All hardwired alarms, switches, and junction boxes shall be protected from tampering and include line supervision.
10. The installation and placement of intercom units and emergency-call boxes in strategic locations shall also require that signage be posted near these devices. The signage, in accordance with Section 10 14 00, SIGNAGE shall communicate the location of the device and its unique identification number, and brief instruction on how to access/use the device. The signage may appear on the device, on a pole or wall near the device location and shall be printed in a manner that is easily read during daylight and hours of darkness.

### **2.2 EQUIPMENT ITEMS**

- #### **A.**
- All systems shall be designed to provide continuous electrical supervision of the complete and entire system.



- B. Noise filters and surge protectors shall be provided for all intercommunications equipment to ensure protection from primary AC power surges and to ensure noise interference is not induced into low voltage data circuits.
- C. All alarm and initiating and signaling circuits shall be supervised for open circuits, short circuits, and system grounds. Main and Uninterrupted Power Supply (UPS) power circuits shall be supervised for any change in operating conditions (e.g. low battery, primary to back up battery, and UPS online). When an open, short or ground occurs in any system circuit, an audible and visual fault alarm signal shall be initiated at the master control station and all remote locations.
- D. Control Unit: Shall consist of the components to constantly monitor and verify alarm activation; identify zone of activation and location of activation.
- E. Audible Signal Device for Duress-Panic: Provides alarm activation and audible sound for alarms, as well as supervisory and trouble signals that shall be distinctive.
- F. Assessment: This capability shall consist of electronic devices required to visually and audibly verify the validity of alarms. Assessment also includes providing indication of tampering, fail-safe, low battery, and power losses.
- G. Alarm Monitoring and Reporting: Shall annunciate information to at least two (2) separate locations. The alarms shall maintain the capability to respond with local and remote visible and audible signals upon activation of an alarm. The alarms shall have the capability of operating in a silent mode, alerting personnel monitoring the system that the device has been activated.
- H. The intercom and emergency call-box systems shall be provided with normally acceptable speech intelligibility, defined as a score of at least 70% in accordance with ANSI S3.2
- I. Master Stations for Emergency Call Box and Security Intercoms:
  - 1. All master stations shall have a "call-in" switch to provide an audible and visual indication of incoming calls from remote stations. Individual visual indication shall identify the calling station and status, and remain actuated until a call is answered by a master station.
  - 2. Master stations shall be equipped with a handset with a switch for private conversations.
  - 3. Intercom master stations shall also have an all-call feature, and have the ability to receive video from a video intercom unit.
  - 4. Master stations shall have the capability to selectively communicate with any remote station by actuating assigned station number on a keypad or select button for that station.
  - 5. Master stations may be standalone or can be integrated with the Physical Access Control System and Database Management. The Contractor will be responsible for the integration of the Master station with the Physical Access Control System and Database Management in accordance with OEM instructions and Section 28 13 16, PHYSICAL ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.
- J. Duress-Panic Alarms:
  - 1. Housing shall be a rugged corrosion-resistant housing of stainless steel or Acrylonitrile Butadiene Styrene (ABS) molded plastic or similar material that is weather and dust proof.
  - 2. Actuating device shall include a minimum of a plunger button whose head is recessed from the face/front edge of the housing and be designed to avoid accidental activation using switch guard or multiple buttons (i.e., requires pressing two (2) buttons simultaneously)
  - 3. Wireless stationary devices will meet the same specifications as Personal Duress/Panic Alarms.

4. Alarm switch/button shall lock-in upon activation until manually reset with key or manufacture provided device.
5. The switch shall be a positive-acting, double-pole, and double-throw switch.
6. Duress/Panic alarms shall meet UL 305 Standard for Panic Alarms. To reduce the possibility of false alarms and ensure installation functionality UL 636 Standard for Holdup Alarms standards shall be met.
7. Alarms used for concealed application requires silent alarm notification to a monitoring station. They shall annunciate at the Physical Access Control System and Database Management, monitored by a central station or direct connect to local police, depending on local ordinance requirements.
8. Shall be capable of being mounted for hand or foot use in a manner that is unable to be viewed by the public. Larger systems use a computer that intercepts and processes alarms and displays them on a monitor. The central computer can make an announcement over facility hand held radios, pagers or telephones, or at the Physical Access Control System and Database Management so that the other security personnel can be immediately notified. These systems shall be hardwired.
9. Components:
  - a. Transmitter
  - b. Locator subsystem
  - c. Receiver
  - d. Software
10. Wiring will be four (4) conductor #18 American Wire Gauge (AWG).
11. Duress-Panic Alarm Technical Characteristics:

Temperature Range	0° to 110°F (-17.8°C to 43.3°C)
Nominal Voltage	12 V DC @ 6 mA
Current	Max 8 mA
Operational Voltage	7 V DC to 15 V DC
Operational life	Rated for 0,000 activations
Battery Activations	500
Actuator	Dual button plunger with activation lock
LED	Bi-color – on and activated

K. Personal Duress-Panic Alarm:

1. These systems are wireless only and can be worn as a belt clip, with a neck lanyard or with a wrist band. These alarms can be either active (manually operated) or passive mode (if detached from body, or body position changes to a prone position) alarm activates. They also provide identification of individual and location.
2. Components:
  - a. Transmitter
  - b. Repeaters (for wireless and increase distance)
  - c. Locator subsystem
  - d. Receiver
  - e. Software
3. Wireless transmitters shall send a periodic check in signal to the main computer or processor. If the signal is not received according to a definable time window, a supervisory alert will be generated. Wireless devices shall report a low battery condition well in advance to the failure of the battery.
4. Shall consist of a compact lightweight transmitter enclosed in a durable fire-retardant ABS plastic case that can be easily worn.

5. Transmitters may use ultrasonic, radio frequency (RF), or infrared (IR) to transmit signals. Each has advantages and disadvantages. Selection of system shall be dependent on defined usage and range of communications required.
6. Sensors shall be adjustable to activate automatically when mounted on a belt and the user is in a horizontal position for longer than one (1) to fifteen (15) minutes. Adjustment capability shall not be accessible to personnel wearing the panic alarm device.
7. Radio frequencies for transmitter will comply with Federal Communication Commission (FCC) regulations.
8. Radio frequency transmitters will use frequency modulation signal hopping.
9. Personal Duress-Panic Alarm Technical Characteristics:

Temperature Range	0° to 110°F (-17.8°C to 43.3°C)
Nominal Voltage	12 V DC @ 6 mA
Current	Max 8 mA
Operational Voltage	7 V DC to 15 V DC
Battery Life	Regular battery 60 hour duration or Nickel-Metal Hydride (NiMH) rechargeable 12 hrs. 20 hr. per charge
Battery Lifespan	500 activations
Actuator	Plunger with activation lock
LED	Bi-color – on and activated
Passive Activation	Adjustable Prone position 1-15 minutes

L. Emergency Call Box Enclosures:

1. Consist of remote call stations, master station and a telephone Private Branch Exchange (PBX). They shall have two-way voice communications. Calls are directed to a pre-programmed extension. These systems are effective for a multi-facility environment or stand-alone facility with a parking structure or large parking lot. In addition, they may contain built-in CCTV system capabilities or can be integrated to work with standalone CCTV systems.
2. Emergency Call Boxes will be housed in an National Electric Manufacturers Association (NEMA) 250 Enclosures for Electrical Equipment compliant enclosures. Call-box enclosure shall include blue light/or similar strobe mounted behind or on top of the call box: A blue light or color lit strobe shall be activated (e.g. to inform others visually that assistance is required) when the emergency switch/button/phone is pressed/taken off-hook and shall flash for the duration of a call.
3. The faceplate shall be constantly lit by ultra bright LEDs.
4. Enclosure and bracket system shall be designed to resist extreme weather conditions and constructed of weather resistant stainless steel.
5. Emergency Call Box Enclosure Technical Characteristics:

Construction	Minimum 11 gauge stainless steel Impact resistant polycarbonate window for lights
Mounting	Wall, pole or kiosk
Power	120 VAC: 44 Watts Maximum or 24 VDC: 18 Watts Maximum
Lighting	Strobe: 1.5 million candlepower 70 flashes per minute. Blue Light: 7 watt high efficiency 10,000 hour compact fluorescent. Faceplate Light: Ultra bright LEDs 100,000 hour lifetime.

M. Emergency Call Boxes:

1. Emergency Call Box shall be indoor/outdoor-rated, Uniform Federal Accessibility Standards (UFAS) and Americans with Disability Act (ADA) compliant, and provide hands-free usage. Phone shall also include cast metal raised letter and Braille signage for UFAS/ADA compliance.
2. Emergency Call Box shall include built-in auto-dialer that dials two (2) numbers: if first number doesn't answer, automatically dials a second number.
3. The System shall include auto-answer to allow for monitoring and initiating calls with an Emergency Phone.
4. Emergency Call Box shall use flush mount enclosure (FME,) shall include two (2) piece housing construction with full front lip to allow tight gasket seal between the speakerphone and enclosure. Screws shall be tamper free.
5. When activated the Emergency Call Box shall automatically place a call to the pre-programmed number(s). If the number is busy it should automatically call a second number.
6. The electronics enclosure shall be capable of using interchangeable faceplates: a single-button faceplate, a two-button faceplate, or a two-button faceplate with keypad.
7. The system shall use a "plain old telephone service" (POTS) line or analog PBX and shall be capable of integration with existing CCTV and Physical Access Control System and Database Management via software at the SMS head-end.
8. Depending on distance and existing phone line capabilities, RF or use of wireless phone connections may be considered. The Contractor and Contracting Officer shall select appropriate system based on facility telecommunication system capabilities and desired system requirements.
9. Monitoring/Diagnostic capability at control and monitoring stations shall include the capability to automatically poll each Emergency Call Box, report incoming calls, identify location, and keep permanent records of all events with the use of a Windows based compatible software package and shall also meet the requirements of the Security Management System (SMS).
10. If speaker/handset stations are used, lifting the handset shall automatically cut out the loudspeaker in the station and all conversation shall be carried through the handset. Where noise does not exceed 55 dB, hands-free operations may be performed from distances up to 20 feet (ft.) (6.096 m). In higher noise environments only a talk-listen switch shall be utilized.
11. If system is a hardware type master station it shall be capable of:
  - a. LED display of identification code for emergency phones;
  - b. Indicate whether call was initiated by pushing button or by an auxiliary device;
  - c. Include RJ11 ports for connection to telephone line and standard telephone; and
  - d. Powered by 9 VDC, 500mA power supply that connects to 120 volt alternating current (VAC).
12. System shall include auto-answer to allow security to monitor and initiate calls with Emergency Call Box.
13. Contractor shall provide the capability to connect up to 8 phones on one (1) phone line while retaining ability to call each phone individually and without affecting performance. System shall also be able to create a closed system without need for any phone lines.
14. The System shall include the capability to record a message identifying the location of the caller.
15. It shall remotely be able to adjust speakerphone & microphone sensitivity.

16. Emergency Call Box Technical Characteristics:

Construction	12 gauge (2.8mm) #4 brushed stainless steel face plate
Operating Temperature	-4°F to +149°F (-20°C to +65°C)
Communication	2-way hands-free communication
Digital Capacity	Up to 18 digits, including pauses, for each of two (2) phone numbers
Dialing Speed	Minimum 10 tones per second
Power Source	Phone line powered (requires 20mA at 24 v off-hook)
Connection	Parallel tip and ring connected to RJ11 connector for quick installation
Memory	Erasable Programmable Read-only Memory (EPROM)
Circuit Protection	Lightening suppressed and full wave polarity guarded
Programming	Non-volatile EEPROM programming can be done from any telephone. No battery back-up needed
Wiring Requirements	1 twisted-shielded pair (gauge depends on distance)
Camera	Option for pin-hole color camera or Integration with existing CCTV
LED	Call confirmation
Activation	Sound or 1.5 in. minimum piezoelectric button
Labeling	“Push for Help” or “Emergency”

N. Strobes and Beacon:

- Used for visual recognition of device activation once an emergency phone or intercom is activated. They provide unit identification and quick location of the caller.
- Strobes and Beacons Technical Characteristics:

STROBE	
Input Voltage	10.5 – 28 VDC or VAC
Input Current	Average 1 amp
Input Current	Peak 3 amp
Intensity	1,000,000 candlepower
Control Circuit Output	2 mA max
Flash Rate	60 – 75 times per minute
BEACON	
Input Voltage	10.5 - 28 VAC or VDC
Input Current	@24.0 : 427 MA

O. Security Intercoms:

- Shall be utilized to assist in controlling entry to a site, parking lot, facility, main and alternate entries, loading dock areas. They are also used for emergencies. These systems shall have both two-way voice communications and video (CCTV) capabilities built in. Intercoms may also have key-pads that allow for specific call connections or may provide a directory. These systems consist of both remote and master stations. Intercom shall be externally powered for distances over 1,500 feet (457.2 meters) (m) from the master control unit.

2. The Intercom shall be programmable from a remote location and have a three number dialing capability per activation button, or include a keypad for dialing authorized and published extensions.
3. The Intercom shall have an internally mounted electronics enclosure and auxiliary power.
4. The Contractor shall be responsible for integration of intercom with auxiliary output to electronic or magnetic door releases, as well as CCTV, as required.
5. Security Intercom Technical Characteristics:

Construction	12 gauge (2.8mm) #4 brushed stainless steel face plate
Operating Temperature	-4°F to +149°F (-20°C to +65°C)
Communication	2-way hands-free communication
Digital Capacity	Up to 18 digits, including pauses, for each of two (2) phone numbers
Dialing Speed	Minimum 10 tones per second
Power Source	Phone line powered or PBX
Connection	Parallel tip and ring connected to RJ11 connector for quick installation
Memory	EPROM
Circuit Protection	Lightening suppressed and full wave polarity guarded
Programming	Non-volatile EEPROM programming can be done from any telephone. No battery back-up needed
Wiring Requirements	1 twisted-shielded pair (gauge depends on distance)
Camera	Option for pin-hole color camera or Integration with existing CCTV
LED	Call confirmation
Activation	1.5 in. (38.1mm) minimum piezoelectric button
Labeling	“Information” or “Help”

### 2.3 INSTALLATION KIT

- A. General: A kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, barrier strips, wiring blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, etc., required to accomplish a neat and secure installation. Unfinished or unlabeled wire connections will not be allowed. Contractor shall turn over to the Contracting Officer all unused and partially opened installation kit boxes, coaxial cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, and physical installation hardware. This is an acceptable alternate to the individual spare equipment requirement as long as the minimum spare items are provided in this count. The following installation sub-kits are required as a minimum:
  - B. System Grounding:
    1. The grounding kit shall include all cable in accordance with UL 444 Communications Cables, and installation hardware required. All grounding will be according to the NEC.
    2. This includes, but is not limited to:
      - a. Coaxial Cable Shields
      - b. Control Cable Shields
      - c. Data Cable Shields
      - d. Conduits
      - e. Cable Duct

- f. Cable Trays
  - g. Power Panels
  - h. Connector Panels
- C. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
  - D. Wire And Cable: The wire and cable kit shall include all connectors and terminals, barrier straps, wiring blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
  - E. Equipment Interface: The equipment interface kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface Systems and Subsystems according to the OEM requirements and this specification.
  - F. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this specification.
  - G. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to correctly provide the system documentation as required by this document and explained herein.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. System installation shall be installed in accordance with NFPA 731 Standards for the Installation of Electric Premises Security Systems and appropriate installation manual for each type of subsystem designed, engineered, and installed.
- B. The location and type of duress, intercom, or call-box to be installed will be in accordance with physical security requirements unique to each VA facility.
- C. For EPPS systems (i.e. use current panic/duress and emergency call boxes) that can operate through existing VA facility telephone system lines, software programming and hardware, refer to Section 27 51 23, INTERCOMMUNICATIONS AND PROGRAM SYSTEMS to integrate additional EPPS equipment.
- D. Concealed duress/panic devices shall be mounted in such a way that their location is only known by the person having knowledge of the activating device location. No wiring shall be exposed to identify the location of the activation device.
- E. Floor mounted duress alarms shall be attached to millwork on floor. When mounted under millwork, wiring shall be routed in millwork to conduit system via flexible conduit.
- F. Hard-wired switches shall be wired to individual alarm points within the Advanced Processing Controller (apC).
- G. Wall and post mounted stations shall be mounted to meet UFAS/ADA requirements and use tamper proof bolts and screws. Testing will be finished before installation of fasteners.

- H. Cleaning: Subsequent to installation, clean each system component of dust, dirt, grease, or oil incurred during installation in accordance to manufacture instructions.
- I. Provisions shall be made for systems in high-noise areas or areas with electrical interference environments.
- J. Adjustment/Alignment/Synchronization: Contractor shall prepare for system activation by following manufacturer's recommended procedures for adjustment, alignment, or programming. Prepare each component in accordance with appropriate provisions of the component's installation, operations, and maintenance instructions.

### **3.2 WIRELINE DATA TRANSMISSION**

- A. Installation: The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable data transmission system.
- B. Identification and Labeling: The Contractor shall supply permanent identification labels for each cable at each end that will appear on the as-built drawings. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified by type or signal being carried and termination points. The labels shall be printed on letter size label sheets that are self laminated vinyl that can be printed from a computer data base or spread sheet. The labels shall be E-Z code WES12112 or equivalent.
- C. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.
- D. Transient Voltage Surge Suppressors (TVSS): The Contractor shall mount TVSS within 3 m (118 in) of equipment to be protected inside terminal cabinets or suitable NEMA 1 enclosures. Terminate off-premise conductors on input side of device. Connect the output side of the device to the equipment to be protected. Connect ground lug to a low impedance earth ground (less than 10 ohms) via Number 12 AWG insulated, stranded copper conductor.
- E. Contractor's Field Test: The Contractor shall verify the complete operation of the data transmission system during the Contractor's Field Testing. Field test shall include a bit error rate test. The Contractor shall perform the test by sending a minimum of 1,000,000 bits of data on each DTM circuit and measuring the bit error rate. The bit error rate shall not be greater than one (1) bit out of each 100,000 bits sent for each dial-up DTM circuit, and one (1) bit out of 1,000,000 bits sent for each leased or private DTM circuit. The Contractor shall submit a report containing results of the field test.
- F. Acceptance Test and Endurance Test: The wire line data transmission system shall be tested as a part of the completed IDS and EECS during the Acceptance test and Endurance Test as specified.
- G. Identification and Labeling: The Contractor shall supply identification tags or labels for each cable. Cable shall be labeled at both end points and at intermediate hand holes, manholes, and junction boxes. The labeling format shall be identified and a complete record shall be provided to the Owner with the final documentation. Each cable shall be identified with type of signal being carried and termination points.



### **3.3 WIRING**

- A. Wiring Method: Install cables in raceways [except in accessible indoor ceiling spaces, in attics,] [in hollow gypsum-board partitions,] and as otherwise indicated. Conceal raceways and wiring except in unfinished spaces.
- B. Wiring Method: Install cables concealed in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

### **3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of video surveillance equipment.
- B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
- C. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
- D. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- E. Remove and replace malfunctioning items and retest as specified above.
- F. Record test results for each piece of equipment.
- G. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

### **3.5 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions and to optimize performance of the installed equipment. Tasks shall include, but are not limited to, the following:
  - 1. Check cable connections.
  - 2. Check proper operation of detectors.
  - 3. Recommend changes to walk trough detectors, X-ray machines, and associated equipment to improve Owner' utilization of security access detection system.

4. Provide a written report of adjustments and recommendations.

### **3.6 CLEANING**

- A. Clean installed items using methods and materials recommended in writing by manufacturer.

### **3.7 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain electronic personal protection system (EPSS) equipment.
  1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
  2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
  3. Review equipment list and data in maintenance manuals.
  4. Conduct a minimum of [four] <Insert number> hours' training.

### **3.8 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS and related sections for contractor responsibilities for system commissioning.

### **3.9 TESTS AND TRAINING**

- A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS and Section 28 05 00 COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY.

**END OF SECTION 28 26 00**

## SECTION 28 3100 - FIRE ALARM AND DETECTION SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 0010 – Electronic Safety and Security General Provisions are applicable to work required of this section.

#### 1.2 QUALITY ASSURANCE

- A. The system installation and wiring shall comply with applicable provisions of the current issue of NFPA 72, International Building Code, International Mechanical Code, Wisconsin Enrolled Commercial Building Code, Americans with Disabilities Act, and codes and regulations of local authorities having jurisdiction.
- B. NEC Compliance: Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories.
- C. UL Compliance and Labeling: Provide fire alarm and detection system components which are UL listed and labeled.

#### 1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
  - 1. National Fire Protection Association; NFPA 70, NFPA 72, NFPA 80, NFPA 20, NFPA 13
  - 2. National Electrical Manufacturers Association
  - 3. Standards of Institute of Electrical and Electronic Engineers
  - 4. International Building Code
  - 5. Occupational Safety and Health Act
  - 6. Wisconsin Administrative Codes
  - 7. NECA Standards
  - 8. Americans With Disabilities Act (ADA)
  - 9. ASME A17.1 State Elevator Code
  - 10. Regulations of local authorities having jurisdiction.

#### 1.4 SUBMITTALS

- A. Submittal data for the fire alarm equipment shall consist of shop drawings outlined in NFPA 72 shop drawing requirements and include but not limited to: block diagrams of layout and operation of the system, full size drawings with device locations and addresses, battery power calculations, audible and visual device power supply calculations, voltage drop calculations, list of device identification and addresses that will be displayed on the control panel(s), quantities of equipment, catalog cuts showing technical data necessary to evaluate the equipment and other descriptive data necessary to describe fully the equipment proposed.
- B. In no instance shall the contract drawings be reproduced for shop drawing submittals.

- C. Contractor is responsible for any fees associated with the review and approval of the fire alarm drawings and product data by the Authority Having Jurisdiction (AHJ). Contractor is also responsible for completion of the required fire alarm system submittal form and submittal of the final fire alarm shop drawings to the AHJ.

## 1.5 RECORD DRAWING REQUIREMENTS

- A. Record drawings shall be provided prior to the time of scheduling of the final inspection. They shall include the location of the overcurrent protection that feeds any fire alarm related equipment and shall be clearly marked on the drawings. Include changes made during system testing and acceptance.
  - 1. The following should be included:
    - a. Alarm initiation devices with addresses.
    - b. Alarm signal devices with module locations/addresses and circuit numbers.
    - c. Door holders and smoke dampers with module location and addressed.
    - d. Air handling units with module and relay locations and addresses.
    - e. Junction pull boxes.
    - f. Layout of conduit with circuit identification.
    - g. 120 VAC power sources for control panels, door holders, and fire/smoke dampers.
    - h. Location of all end of line resistors.
    - i. Calculations for voltage drop on circuits, battery, and audio amplifier sizing.

## 1.6 SYSTEM OPERATION

- A. System Architecture: System shall consist of (2) fire alarm control panels; one for the Courthouse and one for the Law Enforcement Center (LEC) side of the facility. Each system shall be standalone but networked together to share status signals.
  - 1. Alarm, trouble and supervisory signals on the Courtside system shall generate a supervisory signal on the LEC side and vice versa.
  - 2. Audible announcements on the Courtside system shall announce on the LEC side and vice versa through the use of an Interbuilding All Call function. Each system shall also have an All Call function that only announces within that side of the facility.
- B. Control of System: By the Fire Alarm Control Panel.
- C. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
- D. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.
- E. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.
- F. System Reset: All zones are manually resettable from the Fire Alarm Control Panel after initiating devices are restored to normal. Equipment that has been by-passed in software shall not change state of condition during a "reset".

- G. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines. Initial setup for this function shall be the 911 call center within the LEC. Functionality shall be configured to permit future revisions to send calls offsite.
- H. System Alarm Capability during Circuit Fault Conditions: System wiring and circuit arrangement prevent alarm capability reduction when a single ground or open circuit occurs in an initiating device circuit, signal line circuit, or notification-appliance circuit.
- I. Loss of primary power at the Fire Alarm Control Panel initiates a trouble signal at the Fire Alarm Control Panel and the annunciator panels. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.
- J. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke or flame or heat detector, or operation of a sprinkler flow device initiates the following:
  - 1. Notification-appliance operation.
  - 2. Initiation of alarm system.
  - 3. Identification at the Fire Alarm Control Panel and the remote annunciator panels of the device originating the alarm.
  - 4. Transmission of an alarm signal to the remote alarm receiving station.
  - 5. Release of fire and smoke doors hold open if a detector adjacent to the door is in alarm.
  - 6. Recall of elevators if the alarm is initiated by a detector located in an associated machine room, hoistway, or elevator lobby.
  - 7. Shutdown of fans and other air-handling equipment serving the fire zone where alarm was initiated.
  - 8. Initiation of smoke control sequence(s).
  - 9. Closing of smoke dampers in air ducts of system serving the fire zone where alarm was initiated.
  - 10. Recording of the event in the system memory.
  - 11. Initiation of automatic mass notification messages from main panel, annunciator panels and telephone interface.
- K. Alarm Silencing, System Reset and Indication: Controlled by switches in the Fire Alarm Control Panel and the remote annunciator panels.
  - 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
  - 2. Subsequent alarm signals from other devices or fire zones reactivate notification appliances until silencing switch is operated again.
  - 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- L. Operating a heat detector in the elevator shaft or elevator machine room shuts down elevator power by operating a shunt trip device in the circuit feeding the elevator.
  - 1. A field-mounted relay actuated by the Fire Alarm Control Panel closes the shunt trip circuit and operates building notification appliances and annunciators.
- M. Operating a smoke detector in the elevator shaft, elevator machine room or elevator lobby initiates Phase I Emergency Recall Operation automatically recalling the elevator to the main level of egress or the alternate recall level if the main level elevator lobby smoke detector is in alarm.

- N. Operating the fireman's control key for the elevator shall initiate Phase II Operation and bypass all automatic controls.
- O. Smoke detection for zones or detectors with alarm verification initiates the following:
1. Audible and visible indication of an "alarm verification" signal at the Fire Alarm Control Panel.
  2. Activation of a listed and approved "alarm verification" sequence Fire Alarm Control Panel " and the detector
  3. General alarm if the alarm is verified.
  4. Cancellation of the Fire Alarm Control Panel indication and system reset if the alarm is not verified.
- P. Sprinkler flow switch operation initiates the following:
1. General alarm
  2. Dedicated system horn/strobe device located at the fire department connection. This device shall only operate on sprinkler flow.
- Q. Sprinkler valve-tamper switch operation initiates the following:
1. A supervisory, audible, and visible "valve-tamper" signal indication at Fire Alarm Control Panel and the annunciator panels.
  2. Transmission of supervisory signal to remote alarm receiving station.
- R. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system initiates the following:
1. A supervisory, audible, and visible "sprinkler trouble" signal indication at the Fire Alarm Control Panel and the annunciator panels.
  2. Transmission of trouble signal to remote central station.
- S. Remote Detector Sensitivity Adjustment: Manipulation of controls at the Fire Alarm Control Panel causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. Same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity-adjustment schedule changes are recorded in system memory and are printed out by the system printer.
- T. Removal of an alarm-initiating device or a notification appliance initiates the following:
1. A "trouble" signal indication at the Fire Alarm Control Panel and the annunciator panels for the device or zone involved.
  2. Transmission of trouble signal to remote alarm receiving station.
- U. Fire Alarm Control Panel Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.
1. The upper line of the display shall indicate the zone in alarm according to the zone schedule on drawings.
  2. The lower line of the display shall indicate the address of the device in alarm.

V. Automatic Mass Notification:

1. Provide system for activation of up to 5 pre-recorded digital voice messages to be broadcast to building occupants.
2. Custom messages may be up to 3 minutes each.
3. Messages may be actuated from the main fire alarm control panel or remote interface.

W. Manual Mass Notification:

1. Provide telephone interface to allow "All Call" announcements from a dedicated phone number through the fire alarm speakers.
2. Audio alarm signal shall begin with an alarm tone that is distinctly different from the fire alarm annunciation tone. At the end of this tone, the caller shall be able to make announcements similar to microphone push to talk operation through all the fire alarm speakers.
  - a. Each fire alarm control panel shall include a switch to select between "Interbuilding All Call" and "All Call" within a building function.
3. Strobes shall flash in all areas.
4. System shall return to normal operation once the call has ended.

X. LED Lights:

1. Only fire alarm zone lights and "device type" lights shall annunciate with a red LED. Device type, address and exact location shall annunciate on the digital readout.
2. Any by-pass, disable, or trouble condition shall annunciate with an amber LED, a trouble sounder and annunciate on the digital readout. A "trouble pending" control module shall be included.

**1.7 ACTIVE SYSTEMS**

- A. Existing Fire Alarm Equipment: Maintain operation of existing to remain fire alarm systems until new system is fully operational. System downtime shall be kept to a minimum. Provide fire watch personnel as necessary for building occupant notification during downtime. Fire alarm system shall be left in full operational condition at the end of each workday.
- B. Equipment Removal:
  1. Remove from site and legally dispose of existing material not designated for other disposition.

**1.8 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Contractor shall provide the following spare parts in quantities shown, with a minimum of 1/item:

<u>Quantity</u>	<u>Type of Device Present</u>
5%	Smoke detectors and heat detectors
5%	Smoke and heat detector bases
5%	Monitor Modules
5%	Control Modules
1%	Duct detectors with housing and sample tubes

<u>Quantity</u>	<u>Type of Device Present</u>
1%	Voice/strobe Units wall and ceiling variants
1%	Voice units wall and ceiling variants
1%	Strobes wall and ceiling variants
1%	Manual Pull Stations
5 units	Keys and Tools for access to locked and tamperproofed components

## 1.9 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace components that do not meet requirements or that fall within the specified warranty period.
  - 1. Warranty Period: One year from date of Final Acceptance. Full warranty applies throughout the warranty period.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide fire alarm and detection systems of one of the following:
  - 1. Johnson Controls/Simplex
  - 2. Honeywell/Notifier
  - 3. Siemens
  - 4. The equipment supplier shall provide the services of a factory trained representative. They shall supervise the system installation and final connections to the equipment and provide testing to assure that the system is in proper operating condition.

### 2.2 FIRE ALARM AND DETECTION SYSTEMS

- A. General: Provide fire alarm and detection system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated, with the sequence of operations, components and function features indicated.
- B. Materials and Equipment:
  - 1. Wiring System Materials: Provide basic wiring materials which comply with 26 0010 – Electrical General Provisions, 26 0553 – Raceway and Boxes for Electrical Systems, and 26 0519 - Low-Voltage Electrical Power Conductors and Cables; types to be selected by Installer.
    - a. Junction and Pull Boxes:
      - 1) Junction and pull boxes shall be clearly marked. This shall be done by painting the covers red, and properly labeling them.
      - 2) All junction and pull boxes located at or above 8'0" from the floor shall be a minimum size of 4 11/16".
      - 3) No box extensions shall be permitted on new work.



- 4) All junction boxes shall be readily accessible.
- 5) No splicing in device mounting boxes.

C. Manufacturer's Equipment: Provide manufacturer's standard construction equipment for material noted below:

1. Central Fire Alarm Control Panel.
  - a. Cabinet: Front lockable steel enclosure with a 14 gauge door and 16 gauge cabinet body, minimum. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.
    - 1) Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.
    - 2) Mounting: Surface.
    - 3) Keys: Common to all system components.
  - b. Storage:
    - 1) The system stores and logs alarm and trouble events. Each recorded event includes the time and date of the event's occurrence.
    - 2) The system has the capability of recalling alarms, detector verifications, trouble conditions, acknowledgments, and silencing and reset activities in chronological order for the purpose of recreating an event history.
    - 3) Memory: Battery protected random access memory.
    - 4) Alarm Log: 2000 events. Trouble Log: 2000 events.
    - 5) Available Reports:
      - a) Alarm, trouble and test conditions including the time and date of each occurrence.
      - b) Status of each device in the system including detector sensitivity and verification tally.
      - c) Detector trending.
  - c. Alarm and Supervisory Systems: Separate and independent in the Fire Alarm Control Panel. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.
    - 1) Initiating Device Capacity: Adequate for quantity of devices indicated on drawings plus 10 percent.
      - a) Quantity of Simultaneous Alarms: Unlimited.
    - 2) Maintenance Alert: Automatically warns of a contaminated detector prior to false alarm.
    - 3) One additional signal line circuit (SLC) for future.
  - d. Control Modules: Include types and capacities required to perform all functions of fire alarm systems. Each circuit shall have 10 percent spare capacity.
  - e. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.
  - f. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.

- g. Alphanumeric Display and System Controls: Arranged for interface between human operator at the Fire Alarm Control Panel and addressable system components, including annunciation, supervision, and control. Bypass switches shall provide specific alphanumeric display on the LCD annunciator.
- 1) Display: A minimum of 80 characters; alarm, supervisory, and component status messages; and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
  - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
  - 3) Bypass Switches: Activation of a bypass switch allows system testing without operation of the bypassed circuit. A trouble condition is generated upon operation of a bypass switch. Provide bypass switches for the following:
    - a) Remote monitoring station notification.
    - b) Audio circuit.
    - c) Visual circuit.
    - d) Smoke dampers.
    - e) Pressurization fans.
    - f) Elevator recall.
    - g) Fire doors.
  - 4) Control Switches: Switches allow manual control or testing of the following:
    - a) Smoke removal system.
    - b) Stair pressurization system.
    - c) Alarm Test. Operation of switch simulates an alarm condition in the same manner as if a manual station was operated. Notification of the fire department or central monitoring station is bypassed.
- h. Programming:
- 1) System Memory: Non-volatile, programmable.
  - 2) Loading or editing of special instructions and operating sequences allowed as required.
  - 3) Capable of on-site programming to accommodate and facilitate expansion, building parameter changes, or changes as required by local codes.
  - 4) Provisions for disabling and enabling all addressable devices, and all monitoring, signaling and control circuits individually for maintenance and testing purposes.
  - 5) Provisions for distinctly different evacuation tone for disaster warning purposes.
  - 6) Smoke sensor sensitivity:
    - a) Automatic sensitivity adjustment of each sensor based on time of day and day of week.
    - b) Multiple sensitivity settings per sensor.
    - c) Pre-alarm or two-stage function to provide an indication when a sensor reaches 50 percent of its alarm threshold.
  - 7) Contractor shall provide a detailed device description label that includes Room Name, Room Number, and Location in Building for common room name (i.e. Mech Room by main storage).

- i. Voice Alarm: An emergency communication system, includes central voice alarm system components complete with microphones, preamplifiers, amplifiers, and tone generators. Features include the following:
- 1) Two alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by using the central control microphone. All announcements are made over dedicated, supervised communication lines.
  - 2) Signal: Slow whoop.
  - 3) Digitally factory-recorded voice messages:
    - a) Alarm messages:
      - I. Alarm floor.
      - II. Floor above alarm floor and floor below alarm floor.
      - III. All other floors.
      - IV. All clear.
      - V. Weather alert.
      - VI. 5 custom mass notification messages.
  - 4) Message Content: Wording as directed by the Owner.
  - 5) Alarm tone sounds for a maximum of 10 seconds followed by automatic pre-selected voice evacuation messages. At the end of each voice evacuation message, the alarm tone shall resume after an adjustable time delay. The alarm sequence shall continue until the alarm silence switch at the fire alarm control panel has been operated.
  - 6) Status annunciator indicates the status of each voice alarm speaker zone.
  - 7) Manual control switch and gain control for each speaker circuit:
    - a) Provide an "all speaker" talk switch. Include a separate "interbuilding all speaker" talk switch.
    - b) Provide momentary contact switches to manually select the following individual speaker circuits:
      - I. Each building level or approved fire zone.
      - II. Each elevator car.
      - III. Each stairwell.
      - IV. When speaker circuits are active, green LED's shall annunciate the appropriate speaker circuit. Individual speaker control shall be possible with the loss of A/C power.
  - 8) LED to indicate microphone push-to-talk button has been pressed. When speaker circuits are active, green LED's shall annunciate the appropriate speaker circuit. Individual speaker control shall be possible with the loss of A/C power.
  - 9) Amplifiers:
    - a) Size: 100 watts, minimum.
    - b) Self-contained filtered 24V DC power supply.
    - c) Transformer and amplifier monitor circuits.
    - d) Output: 25VRMS.
    - e) Frequency Response: 120 Hz to 12,000 Hz.
    - f) Quantity: As required to operate all system speakers simultaneously with 10 percent spare capacity.
    - g) Back-up amplifier quantity; One for the Courthouse and one for the Law Enforcement Center.
    - h) Microphone:
      - i) Hand-held, push-to-talk.
      - j) Dynamic communication type.
      - k) Frequency Range: 200 Hz to 4,000 Hz.

- l) Self-winding five-foot coiled cable.
    - m) Stored within control panel.
  - j. Control Switches:
 

	<u>Access Level</u>
City disconnect with digital readout (for both alarms and troubles)	Level 3
Audio bypass with digital readout	Level 3
Visual circuit bypass with digital readout	Level 3
Smoke damper bypass with digital readout	Level 1
Elevator bypass	Level 1
Fire door bypass	Level 1
Activation of elevator smoke damper	Level 1
  - k. Provide air handler shutdown by specific unit or by fire zone (i.e. floor). Switch cannot be activated unless one or more of the following conditions occur:
    - 1) Fire Alarm Control Panel is in access level 3.
    - 2) Panel is in alarm condition.
  - l. Fire alarm control panel power shall be supplied by dedicated circuit(s).
- 2. Manual Pull Stations
  - a. Description: Fabricated of metal, and finished in red with molded, raised-letter operating instructions of contrasting color.
    - 1) Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm.
    - 2) Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
    - 3) Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
    - 4) When surface-mounting pull stations, fire alarm equipment provider shall provide back boxes to match pull stations.
- 3. Smoke Detectors
  - a. General: Include the following features:
    - 1) Operating Voltage: 24-V dc, nominal.
    - 2) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
    - 3) Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
    - 4) Sensitivity: Can be tested and adjusted in-place after installation.
    - 5) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
    - 6) Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the Fire Alarm Control Panel for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the Fire Alarm Control Panel.
  - b. Photoelectric Smoke Detectors: Include the following features:
    - 1) Sensor: LED or infrared light source with matching silicon-cell receiver.
    - 2) Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
    - 3) Magnetically actuated test switch.

- 4) Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.
- c. Duct Smoke Detector: Photoelectric type.
  - 1) Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
  - 2) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
  - 3) Remote Test Switch: Mount near mechanical room door or suitable maintenance type space on stainless steel cover plate. Include floor plan with protective cover to indicate location of corresponding duct smoke detector.
4. Other Detectors
  - a. Heat Detector, Combination Type: Actuated by either a fixed temperature or rate of rise of temperature.
    - 1) Analog temperature measuring device with setpoint (rating) set by Fire Alarm Control Panel.
    - 2) Mounting: Plug-in base, interchangeable with smoke detector bases, where available.
    - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the Fire Alarm Control Panel.
5. Notification Appliances
  - a. Description: Equip for mounting as indicated and have screw terminals for system connections.
    - 1) Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
  - b. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "ALERT" is engraved in minimum 1-inch- high letters on the device.
    - 1) Rated Light Output: Field selectable 15 through 110 candela minimum per UL 1971 for ADA use unless otherwise indicated on drawing or required to meet NFPA 72 criteria.
    - 2) Strobe Leads: Factory connected to screw terminals.
    - 3) Synchronized operation.
    - 4) Mounting:
      - a) Ceiling: Flush with white baffle.
      - b) Wall: Surface with red or white housing.
      - c) Include skirt for surface mounted devices which do not conceal a standard 4-inch junction box.
  - c. Voice/Tone Speakers:
    - 1) High-Range Units: Rated 2 to 15 W.
    - 2) Low-Range Units: Rated 1/4 to 2 W.
    - 3) Minimum sound pressure 86dB at 10' with 1 watt tap
    - 4) Size:
      - a) Ceiling-Mounted Speakers: 8 inches.
      - b) Wall-Mounted speakers: 4 inches.
    - 5) Mounting:
      - a) Ceiling: Flush with white baffle.
      - b) Wall: Surface with red or white housing.
      - c) Include skirt for surface mounted devices which do not conceal a standard 4-inch junction box.
    - 6) Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
    - 7) Voltage: Dual-voltage, field selectable at 25 or 70.7 nominal Vrms.

- 8) Listing: UL 1480 for Fire Protective Signaling Systems
- d. Fire Suppression System Speaker/Strobe
  - 1) Weather resistant 24VDC combination audible/visual device to be located above the fire department connection.
  - 2) Wall mounted.
  - 3) Minimum sound pressure 86dB at 10' with 1 watt tap
  - 4) Rated light output: 75 candela
- 6. Magnetic Door Holders
  - a. Description: Units equipped for wall or floor mounting as indicated and are complete with matching door plate.
    - 1) Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
    - 2) Wall-Mounted Units: Surface mounted, unless otherwise indicated.
    - 3) Contact Plate: Adjustable.
    - 4) Armature Plate: Door mounted, adjustable 95 deg. horizontal, 5 deg. vertical.
    - 5) Rating: 24-Vdc.
  - b. Material and Finish: Match door hardware.
  - c. Existing Units: Where existing units are shown for reconnection, provide necessary relays to operate at 24V dc.
  - d. Mount units high on door.
- 7. Remote Annunciator Panels
  - a. Description: LCD (liquid crystal display) duplicate annunciator functions of the Fire Alarm Control Panel for alarm supervisory, and trouble indications. Also duplicate manual switching functions of the Fire Alarm Control Panel including, acknowledging, silencing, reset, and test. Lockable steel enclosure keyed to match.
    - 1) Mounting: Surface cabinet.
  - b. Display Type and Functional Performance: Alphanumeric display same as the Fire Alarm Control Panel. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the Fire Alarm Control Panel.
  - c. Provide LCD back box where surface mounting is necessary.
  - d. No microphone required at remote annunciator locations.
- 8. Signal Circuit Remote Power Supply
  - a. General: Filtered, regulated, power limited with trouble indication; with emergency power supply.
  - b. Cabinet Lockable steel, surface-mounted enclosure, keyed to match, Fire Alarm Control Panel.
- 9. Battery Power Supply
  - a. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.
    - 1) Battery Nominal Life Expectancy: 4 years as a minimum.
  - b. Battery Capacity: Comply with NFPA 72 for supplying a minimum of 24 hours of operation in normal condition, followed by no less than 15 minutes in full alarm for a system operating without a backup generator.
  - c. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

- d. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.
10. Addressable Interface Devices
- a. Monitor Module: Microelectronic module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts; allows individual monitoring of non-addressable points.
  - b. Control Module: Microelectronic module listed for use in providing a multiplex system address to relays for system control functions.
    - 1) Relay: 24 VDC coil with red LED when in the "alarm" state; contacts rated 10A, 115 VAC, minimum; suitable for control function required.
11. Digital Alarm Communicator Transmitter
- a. Listed and labeled under UL 864 and NFPA 72.
  - b. Cellular/IP Communicator:
    - 1) The cellular communicator connects directly to the primary and secondary analog UL Listed Fire Alarm Control Panel telephone ports.
    - 2) The Communicator will communicate to GSM networks in the area including 4G and 5G. The multi-GSM platform technology automatically detects and chooses the best network in the area based on signal strength and immediately self-adjusts for operation.
    - 3) Supports both dynamic (DHCP) or Public and Private Static IP addressing.
    - 4) Communicates over any type of customer-provided Ethernet 10/100 Base network connection (LAN or WAN), DSL modem or cable modem.
    - 5) Data transmits over standard contact-ID protocol is secured with the industry's advanced encryption standard (AES 256 bit).
    - 6) Dual path communications: Uses Internet or GSM as primary.
    - 7) Provide with programming tools as required.
    - 8) Diagnostic LEDs: Signal strength and status indications.
    - 9) IP and GSM tested every day.
    - 10) All circuits shall be power-limited, per UL864 requirements.
12. Fire Alarm Documentation Cabinet
- a. Provide fire alarm documentation cabinet in accordance with NFPA-72 Cabinet to be labeled "SYSTEM RECORD DOCUMENTS". Space Age Systems SRD ACE-11 or equal.
  - b. Provide documentation cabinet for each fire alarm control panel and mount adjacent to panel.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Contractor/Installer shall meet with Owner prior to performing any work on existing/new system(s). Meeting shall determine existing building system functions and approach Contractor/Installer will take to remove the existing system and determine Contractor's/Installer's plan to install new system which includes raceway runs, typical wiring practices, and device and equipment installation, also to provide Contractor/Installer with Owner's expectations.

- B. The locations and spacing of alarm initiating devices and strobes indicated on the drawings are approximate. The equipment supplier shall verify device requirements and spacing and shall add devices as required to satisfy governing authorities. It shall be the responsibility of the equipment supplier or their representative to determine the type of detector required by local authorities for each type of installation.
- C. Install the fire alarm system in accordance with approved manufacturer's wiring diagrams. Furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for a complete installation. Boxes shall be installed in accessible spaces without requiring the removal of light fixtures or any other equipment.
- D. Coordinate system programming with the authority having jurisdiction.
- E. Provide 120 volt power to remote signal circuit power supplies.
- F. Provide fire alarm system power to remote annunciator panels.
- G. Circuit breakers shall be identified and locked in accordance with NFPA 72. Provide Space Age Electronics model ELOCK-FA circuit lockout kit. Apply labels furnished with kit.
- H. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.
- I. Provide switch and fuse stat's (type SOU) installed within the Fire Alarm Control Panel disconnect 120 VAC power and separately all battery power.
- J. Coordinate the installation of equipment and devices that pertain to the work of other trades with the appropriate contractors.
  - 1. Provide connections to 120V smoke dampers provided by the mechanical contractor. Install 120V indicator lights provided with the dampers and wire to position switches.
    - a. Provide dedicated 120 volt circuits for smoke dampers.
  - 2. Provide shut-down relays to initiate HVAC shut down. Locations indicated on the fire alarm drawings are diagrammatic. Coordinate relay installation and HVAC unit shut-down with temperature controls contractor.
  - 3. Provide monitoring of fire suppression system. Coordinate installation with the Fire Suppression System installer.
    - a. Activation of water flow shall initiate general alarm.
    - b. Activation of water flow shall initiate the dedicated combination speaker and visual device located above the fire department connection. This device shall not initiate under any alarm other than water flow.
    - c. Activation of valve tamper switches shall initiate a supervisory alarm.
  - 4. Provide monitoring and control of elevator in accordance with ASME A17.1, International Building Code and State Elevator Code. Coordinate installation with the elevator installer.
    - a. Provide primary and secondary recall signals.
    - b. Provide fireman's operation (fireman's helmet) signal.
    - c. Monitor shunt-trip control power.
    - d. Provide shunt-trip signal in accordance with ASME A17.1. Provide timed delay of shunt-trip signal to allow elevator to be recalled. Coordinate length of time delay with elevator vendor.
    - e. Provide signal to deactivate battery lowering circuit for hydraulic elevator (where applicable).



### 3.2 DEVICE INSTALLATION

- A. Provide devices as indicated on drawings and as required to perform specified functions.
- B. Initiating Devices:
  - 1. Smoke Detectors:
    - a. Cover all smoke detection devices immediately after installation to maintain cleanliness.
    - b. Install within five feet of each door held open by the fire alarm system.
    - c. Where adjacent to an air shaft, supply diffuser or return grille, install smoke detector 36 inches minimum from the edge of the diffuser or grille.
    - d. Provide a smoke detector within 10 feet of each remote power supply panel.
  - 2. Duct Detectors:
    - a. Provide duct type smoke detectors in the return ductwork as indicated.
    - b. Locate duct smoke detector within 5' of fire dampers where a detector is indicated to be installed in a duct with a smoke.
    - c. Provide a remote alarm LED indicator for each duct smoke detector which is not readily visible or which is located above a ceiling or on a roof. Mount in an easily accessible and readily visible location. Label with the name of the unit served by the detector. Indicate whether the detector is installed in the supply or return ductwork.
    - d. Provide a labeled test switch with LED indicator for each duct smoke detector. Install switch at a height between 48 inches and 72 inches above finished floor.
  - 3. Provide heat detectors in areas where smoke detectors would be subject to false alarm.
  - 4. Program address for each device as directed by Owner or stated elsewhere in specification.
  - 5. Program device output text by address and geographic location.
  - 6. Provide an addressable interface module for each non-addressable initiating device.
- C. Signaling Devices:
  - 1. Where plans indicate a signaling device installed adjacent to a manual station, install the signaling device on the wall directly above the manual station.
  - 2. Provide a minimum of two weatherproof audible signaling devices of the same type as other signaling devices provided with the system. The audible signaling devices will be located by the fire department connection to each building. Owner will determine the exact locations. Mount the devices on the exterior of the building. Provide a separate circuit for exterior audible signaling devices.
  - 3. In sprinkled buildings, provide a 24VDC system audible/visual device above the fire department connection. Coordinate location with division 21. Provide manual bypass from the Fire Alarm Control Panel.
  - 4. Set taps for toilet room speakers at 1/4 watt where toilet room is under 1000 square feet.
  - 5. Signaling devices shall be completely deactivated by pressing "signal silence".
  - 6. Audibles shall be placed so that they can be heard a minimum of 15 decibels above the ambient decibel level in all locations (refer to NFPA 72G and ISBC 17.705(12)).
- D. Control Devices:
  - 1. All devices controlled by the Fire Alarm Control Panel (i.e. dampers, doors, elevators, etc.) shall be operated by the use of "control modules" and not by relay type device on detector bases. No auxiliary equipment shall be directly connected to LMX control modules. Control modules shall activate a 24VDC relay with LED when in the "alarm".

2. Elevators: Verify recall requirements with local codes, authorities, and installers prior to system programming. Provide control modules and relays as required.
  3. Provide a control module and relay for each door or group of doors to be held open.
  4. Provide control modules and relays as required to implement the required control sequences.
  5. Provide control modules and relays for remote indication of alarm and trouble conditions.
  6. Provide monitor module(s) where conventional non-addressable heat detectors and similar devices are installed.
- E. Door Holders:
1. Mount at the top of each door to be held open unless otherwise indicated.
  2. Mount the magnet on the wall and the contact plate on the door. Provide extensions as necessary to assure proper mating between the magnet and contact plate. Magnet is to maintain hold of door under normal conditions.
  3. Adjust so the door is held parallel to the wall on which the magnet is mounted.
  4. Electromagnetic door holders which are indicated to be integral with a door closer shall be furnished by the Design Professional. Provide wiring so the door holders are normally energized from the fire alarm power supply.
- F. Cabinets:
1. Mount Fire Alarm Control Panel and remote cabinets a maximum of 72 inches above finished floor to the top of the cabinet. Provide a 4-inch space between adjacent cabinets.

### **3.3 WIRING INSTALLATION**

- A. Wiring Method: Use Class A wiring for communication between fire alarm panel equipment and Class B for field mounted devices. Install wiring in metal raceway according to Division 26, Section 26 0533 - Raceways and Boxes for Electrical Systems. Conceal raceway except in unfinished spaces and as indicated. Surface-mounted Wiremold shall be size 700 minimum.
- B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors. Do not install spare conductors in conduits or junction boxes.
- C. Cable Taps: All cables in the fire alarm control panel, junction boxes, and pull boxes shall be clearly marked in English (i.e. SLC 1, 3rd Floor Speakers, etc.). Label all junction box covers to indicate circuits and/or devices enclosed. Label inside cover of all junction boxes in finished areas. Label outside cover of all junction boxes in unfinished/concealed areas.
- D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red and provide circuit labels on inside of cover.
- E. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the Fire Alarm Control Panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

- F. Install end-of-line resistors at the farthest device from panel or module in a separate junction box clearly marked "End-of-Line Resistor."
- G. Conductors (minimum size and color) and raceways shall be provided as listed below, unless otherwise recommended by the system manufacturer or required by the authority having jurisdiction:
- |    |                            |       |                |                          |
|----|----------------------------|-------|----------------|--------------------------|
| 1. | 120VAC                     | 12AWG |                |                          |
| 2. | Initiating circuits        |       | #18 tw/sh pair | White (+)      Black (-) |
| 3. | Audible signaling circuits |       |                |                          |
| a. | Horns/bells                |       | #14AWG         | Red (+)      Black (-)   |
| b. | Speakers                   |       | #14 tw/sh pair | Red (+)      Black (-)   |
| 4. | Module power               |       | #14AWG         | Violet (+)      Blue (-) |
| 5. | Resettable module power    |       | #14AWG         | Yellow (+)      Gray(-)  |
| 6. | Visual signaling circuits  |       | #14AWG         | Red (+)      Black (-)   |
| 7. | Door holder/smoke dampers  |       | #14AWG         | Brown (+)      White (-) |
| 8. | Control circuits           |       | #14 AWG        |                          |
- H. Conduit fill and box fill never to exceed 50%.
- I. No spare conductors shall be installed in conduits or junction boxes.
- J. 3M #130C rubber tape (or approved equal) shall be used to insulate grounding shields.
- K. If surface Wiremold is specified, it shall be no smaller than 700 size.
- L. All junction and pull boxes located at or above 8'-0" from the floor shall be a minimum size of 4-11/16" square by 2-1/8" deep.
- M. No box extensions shall be permitted on new work.
- N. All fire alarm devices, junction and pull boxes shall be installed so they are accessible without removing light fixtures, equipment, conduits, junction boxes or other items.
- O. No splicing will be allowed in device mounting boxes.
- P. "End of Line Resistors" shall be located at the device that is farthest away from the panel or module.
- Q. All devices being controlled by the fire alarm control panel (i.e. dampers, doors, etc.) shall be operated by the use of control modules and not by relay type devices in detector bases. No auxiliary equipment shall be directly connected to an addressable control module. Each control module shall activate a 24 vdc relay with LED when in the "alarm" state.
- R. Back boxes shall be provided by equipment supplier for any surface-mounted pull stations or signaling devices.
- S. T-taps may be used for signaling line circuits if manufacturer's recommendations are followed.

### **3.4 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals according to Division 26, Section Identification for Electrical Systems.
- B. Install instructions frame in a location visible from the Fire Alarm Control Panel.
- C. Circuit breakers shall be identified and locked in accordance with NFPA 72. Provide Space Age Electronics model ELOCK-FA circuit lockout kit. Apply labels furnished with kit. Affix the name and telephone number of the local service organization to the inside of the door of the Fire Alarm Control Panel and each remote cabinet.
- D. Label each control module to indicate the equipment controlled.
- E. Maintain wiring color codes throughout the system.
- F. All labels shall be on the inside of the cover.

### **3.5 GROUNDING**

- A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

### **3.6 ACCEPTANCE TESTING**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.
- B. Electrical Contractor shall be responsible for performing a "Pre-Test" of the Fire Alarm System and preparing/ completing "Test Log".
  - 1. All equipment shall be installed prior to completing "Pre-Test".
  - 2. Scope of the Pre-Test is to:
    - a. "Align, adjust, and balance the system."
    - b. Confirm compliance with the drawings and specifications.
    - c. Install, test and check for operation of 100% of all fire alarm equipment and items being controlled by the fire alarm system.
  - 3. Manufacturer's representative is to be involved in the pre-test.
  - 4. Perform a thorough cleaning of the fire alarm system so each detector's chamber value reads less than 50%.
  - 5. At completion of the pre-test, the fire alarm system is to be complete and ready for owner acceptance.
  - 6. Complete a "Test Log", a written record of inspections, tests, and detailed test results.

- C. In preparation for the final test, Contractor shall:
1. Submit a "Test Log" and test forms from NFPA 72 and include a print out proving detector chamber values of less than 50% for all detectors.
  2. Provide a letter certifying pre-test compliance and a list of witnesses.
  3. Provide an up to date and complete printout of software at the time of final inspection and after any and all corrections or changes.
  4. Coordinate with Owner to record automatic messages for fire alarm and mass notification conditions.
- D. Contractor shall perform a Final "Minimum System Test" per NFPA 72.
1. Contractor shall test all equipment per minimum system testing requirements and maintain a "Test Log".
  2. Contractor to have sufficient personnel to conduct the test efficiently.
  3. Upon completion of the Final Test Contractor will submit the Test Log.
  4. Owner's representative has the authority to void the Final Test if it is proven during the Final Test that the Fire Alarm system installation is not complete.
    - a. Voiding the Final Test will require Contractor to schedule another Final Test.
  5. Upon approval of Final Test, successful owner training and submittal of completed "As-Built" drawings and O&M manuals, Owner will provide Contractor with acceptance of new Fire Alarm System.
    - a. Owner acceptance does not constitute "Project Closeout" or completion of "Final Punch List"
    - b. Owner acceptance only relieves Contractor of testing requirements, it does not relieve Contractor of other contract requirements.
    - c. Final Testing does not constitute Owner training.
    - d. Owner acceptance provides approval to activate the new Fire Alarm System as the primary system.
  6. Contractor shall perform final test in the presence of manufacturer's representative, Owner's representatives, and necessary local code authorities.
- E. Minimum System Tests' test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
1. Verify the absence of unwanted voltages between circuit conductors and ground.
  2. Test all conductors for short circuits using an insulation-testing device.
  3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohm meter. Record the circuit resistance of each circuit on record drawings.
  4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
  5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
  6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.

7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
  8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
  9. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.
  10. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of test
- F. The manufacturer's authorized representative shall perform a 100% quality inspection of the final installation and in the presence of Contractor, Owner's Representative and local code and fire authorities, shall perform a complete finished test of all aspects of the system. A system certification verifying the proper system operation shall be required prior to acceptance.

### **3.7 CLEANING AND ADJUSTING**

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer. Provide detector cleaning report proving a maximum chamber value of 50% for all detectors.

### **3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours training.
  2. Provide a minimum of 8 hours of software program training by a factory trained representative.
  3. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
  4. Schedule training with Owner, with at least seven days advance notice.

### **3.9 MAINTENANCE**

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.
- B. Provide a maintenance contract from the local service organization beginning on the date of Substantial Completion and remaining in force throughout the warranty period. Include required NFPA testing at times scheduled by Owner.
- C. Provide Owner with a proposal from the local service organization for a one-year maintenance contract beginning at the end of the warranty period.

**END OF SECTION 28 3100**

## SECTION 28 50 00 - ACCESS CONTROL SYSTEM

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements, Division 8 – Openings, and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this access control and wired & wireless duress notification in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system.

#### 1.3 CODES AND STANDARDS

- A. All work shall be done in accordance with the applicable portion of the following codes and standards:
  - 1. National Electrical Code
  - 2. Local Electrical Code
  - 3. National Fire Protection Association
  - 4. National Electrical Manufacturers Association
  - 5. Standards of Institute of Electrical and Electronic Engineers
  - 6. Applicable Building Codes
  - 7. Occupational Safety and Health Act
  - 8. Wisconsin Administrative Codes
  - 9. ANSI TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
  - 10. ANSI TIA-526-14-C Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
  - 11. ANSI TIA-568-C.0 Generic Telecommunications Cabling For Customer Premises
  - 12. ANSI TIA-568-C.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
  - 13. ANSI TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
  - 14. ANSI TIA-568-C.3 Optical Fiber Cabling Components Standard
  - 15. ANSI TIA-568-C.4 Broadband Coaxial Cabling and Components Standard
  - 16. ANSI TIA-569-D Telecommunications Pathways and Spaces
  - 17. ANSI TIA-570-C Residential Telecommunications Infrastructure Standard
  - 18. ANSI TIA-598-D Optical Fiber Cable Color Coding
  - 19. ANSI TIA-606-B Administration Standard for Commercial Telecommunications Infrastructure
  - 20. ANSI TIA-607-B Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - 21. ANSI TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard
  - 22. National Fire Protection Agency (NFPA - 70), National Electrical Code (NEC)

#### **1.4 SUBMITTALS**

- A. Submittal data for access control cabling and components shall consist of:
  - 1. Catalog cuts showing technical data necessary to evaluate the materials.
  - 2. Shop Drawings of door locations and access control type per location

#### **1.5 WORK BY OTHERS**

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes as needed, and conduit paths for use by Access Control Contractor. In general, the following is provided:
  - 1. Available space on Telecom Room plywood wall to surface mount head end equipment as required with telecommunications room ground bus bar available for grounding.

#### **1.6 FIRESTOPPING**

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire and/or smoke walls. Contractor shall see architectural drawings for walls that require fire rating.

#### **1.7 ACCEPTABLE ACCESS CONTROL CONTRACTORS**

- A. The following contractors are pre-approved to bid this job:
  - 1. Access Control Contractor shall be a manufacturer authorized Dealer, verifiable by the manufacturer's representative. The Access Control Contractor shall also provide as a submittal documentation that they have been and continue to be an established manufacturer authorized dealer in good standing for a minimum of six continuous months before the project bid date. Bidding the project without certifications and attempting to acquire certifications after the bid is not acceptable.
  - 2. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

### **PART 2 - PRODUCTS**

#### **2.1 ACCESS CONTROL CABLING AND COMPONENTS**

- A. Acceptable Access Control System Manufacturers:
  - 1. Panasonic MonitorCast (existing)
- B. Acceptable Access Control System Components:
  - 1. Card Readers
    - a. Provide per Division 8 Door Hardware Specifications
  - 2. Video Door Station
    - a. Aiphone
    - b. Panasonic
    - c. Axis



- d. Approved equal
  - 1) Video door station headend shall have the ability to unlock door from identified County employee location to location of video door station.
  
- 3. Access Control Cable
  - a. CSC WESSCO
  - b. Belden
  
- 4. Access Control Lock Out Button
  - a. STI: SS2-4-3-2-ZA-EN,
    - 1) Button Labeling Shall be "LOCK OUT"
  
- 5. Access Control Buzz Open Button
  - a. Bosch: ISC-PB1-100
  - b. Approved equal
    - 1) Door release shall unlock door identified on Plans upon press of the button.
  
- 6. Access Control Request to Exit
  - a. Provide per Division 8 Door Hardware Specifications
- 7. Access Control Power Supply and Battery Backup
  - a. Provide per Division 8 Door Hardware Specifications
- 8. Access Control Door Controller
  - a. Provide per Division 8 Door Hardware Specifications
  
- 9. Additional Components
  - a. Duress/Panic Notification
    - 1) Wired
      - a) Bosch/Inovonics
      - b) DMP
      - c) Honeywell
      - d) Approved equal
    - 2) Wireless and Portable
      - a) Bosch/Inovonics
      - b) DMP
      - c) Honeywell
      - d) Approved equal

C. Additional Access Control Requirements:

- 1. Access Control Doors shall be added to existing Panasonic access control system. Contractor shall provide licensing necessary for doors to be added to the MonitorCast platform.
- 2. The point-to-point intercom systems shall integrate with access control so that the County employees may 'buzz-thru' those waiting at a door. Coordinate with Division 27 50 00 Contractor.
- 3. Jefferson County is using a Detention System Integrator to provide security scope to the jail as well as additional security scope to the courtrooms and other areas. Provide scope as outlined in documents provided by Stanley Consulting. The Access Control Contractor shall install and configure all local access control panels in the identified telecommunication rooms on the construction plans. Unless noted otherwise.
- 4. The Access Control Contractor shall program all security system databases hardware configurations.
- 5. The Access Control Contractor shall test and certify all access control communication and operation in accordance with the specifications and manufactures recommendations.

6. The Access Control Contractor shall provide and install all cabling necessary for a complete and operational system taking into account all access control system devices called out on the plans (door contacts of all types, card readers, request to exit devices either internal to door hardware or surface mounted, and electrified door hardware of all types).
  - a. Access control cabling shall be home-run to the main system hardware, no splicing.
7. Any door identified on the plans that has any of the system components {door contacts (sometimes called position switches) of all types, card readers, request to exit devices, electrified door hardware of all types} shall be considered an access control system door.
8. Any door that is considered an access control system door shall have door contacts that can ensure the door is in the closed position and that the door is latched unless specifically noted otherwise. Both sides of a contact shall have a dedicated alarm point in the system.
9. If an electric strike is being provided with a latch bolt monitoring contact internal to the strike, a door slab contact shall still be provided to monitor the position of the slab. It shall be the Access Control Contractors responsibility to:
  - a. Verify that a suitable latch bolt monitoring contact is being specified in the door hardware or point out that what is specified is not compatible with the access control product being provided or the system requirements placed upon the Contractor.
  - b. Provide and install a door slab contact which, when these two are used together, accomplish the requirements of knowing that the door slab is physically closed, and the door hardware is engaged therefore ensuring a secured doorway.
10. The Access Control Contractor shall provide door controllers for all access control doors on the project that require a controller.
11. The Access Control Contractor shall provide and install all devices not specifically identified on the plans which are required for a complete and operational system for all access control system doors.
12. The Access Control Contractor shall provide and install one client software package on an Owner provided computer.
13. The Access Control Contractor shall provide training to all client operators and or managers identified by the client.
14. The Access Control Contractor shall furnish 250 proximity cards.
15. ADA door operation: Doors that are part of the access control system and have ADA electric openers shall be subject to the following hardware/software requirements.
  - a. The Access Control Contractor shall provide and install the necessary physical equipment and/or programming or other soft services necessary to meet these requirements.
  - b. The card reader shall be located in close proximity to the ADA button (whether on the building wall or on a bollard or equivalent).
  - c. During times when the system is scheduled to have the door of interest unlocked, pressing the ADA button (no card presentation required) shall physically open the door (and retract the latch as necessary). The access control system shall only unlock door trims during the unlocked door schedule (the latch shall remain engaged so the door cannot be opened by the wind or by people without using the door hardware). The Access Control Contractor shall coordinate with door hardware provided.
  - d. During times when the system is scheduled to have the door of interest locked, pressing the ADA button without a valid card presentation shall not activate any electric door hardware or electric opening devices.

- e. During times when the system is scheduled to have the door of interest locked, pressing the ADA button after a valid card presentation shall activate any electric door hardware necessary to unlatch the door and activate the electric opening device(s).
  - 1) The valid card presentation shall only allow activation of these electrical systems for a limited amount of time after the card presentation.
  - 2) At no time shall a valid card presentation automatically activate the electric door opening device.
  - 3) Pressing the ADA button to have the door electrically open shall always be required, subject to the requirements listed above.
- 16. The Access Control head end (all cabinets if multiple) shall be furnished and installed with a minimum 7ah of battery backup serving no more than 8 doors each (i.e. if one panel serves 16 doors, then two 7ah batteries are required minimum). A battery backed power supply of the same manufacturer as the access control system shall be used if available, otherwise see this spec. 2.01 B.8 for an acceptable manufacturer to use.
- 17. All duress systems components shall match the manufacturer's system and be turn-key.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install systems cables and auxiliary materials as indicated in accordance with access control manufacturer's written instructions, and recognized industry practices.
  - 1. Contractor shall use hook and loop type fasteners on all security cable. Tie wraps shall not be used.
- B. Identify all cables as to field location.
  - 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
  - 1. Contractor shall provide all instruments for testing the cables.
  - 2. Contractor shall demonstrate in the presence of Owner's representative that the access control is complete and operational.
  - 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to Owner within 14 days.
  - 1. Two hard copies shall be provided to Owner detailing the entire access control after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

#### **3.2 COMMISSIONING**

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

**END OF SECTION 28 50 00**

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## SECTION 28 60 00 - VIDEO SURVEILLANCE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The requirements of Division 00 – Procurement, Contracting and Warranty Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

#### 1.2 DESCRIPTION OF WORK

- A. The work included under this specification consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this surveillance system in compliance with the specifications and drawings. Contractor will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

#### 1.3 SUBMITTALS

- A. Submittals for all Manufacturer and Contractor certifications (noted below) shall be submitted first.
- B. Submittal data for surveillance cabling and components shall consist of:
  - 1. Catalog cuts showing technical data necessary to evaluate the materials.
  - 2. Shop drawings of floor plans showing camera locations and types

#### 1.4 WORK BY OTHERS

- A. Unless noted otherwise, the building's Electrical Contractor will provide field device backboxes as needed, and conduit paths for use by surveillance Video Surveillance Contractor. In general, the following is provided:
  - 1. Grounded 19" data rack in Telecom Room by Telecom Contractor to mount head end equipment to.
  - 2. Available space on Telecom Room wall for power supply.

#### 1.5 FIRESTOPPING

- A. Contractor shall be responsible for firestopping all conduit sleeves and cable tray where required to maintain integrity of fire and/or smoke walls. Contractor shall see architectural drawings for walls that require fire rating.

#### 1.6 ACCEPTABLE VIDEO SURVEILLANCE CONTRACTORS

- A. The following contractors are pre-approved to bid this job:
  - 1. Video Surveillance Contractor shall be a Panasonic certified dealer in good standing for a minimum of six continuous months before the project bid date. This shall include factory trained and certified technicians in house for the installation of this project (six months experience applies here also). The dated dealer certification document and the dated technician training certificate are each required submittal items.

2. The four or more submittal items (if multiple technicians) noted above are all criteria which determine if the Contractor is authorized to enter the team and begin work. No project work shall be authorized until these submittals are reviewed with a favorable response. Product data submittals are a separate submittal package and shall only be reviewed after the above items are resolved.
3. Contractor shall be located within 125 miles of the construction site to establish a potential two-hour response time for ongoing customer needs after construction completion.

## **PART 2 - PRODUCTS**

### **2.1 VIDEO SURVEILLANCE CABLING AND COMPONENTS**

- A. Acceptable Manufacturers:
  1. Owner has an existing Panasonic Video Insight VMS system with Panasonic iPro cameras.
- B. Additional Video Surveillance Requirements:
  1. All power and video cables shall be home-run, no splicing.
  2. Contractor shall coordinate with Owner in assigning specific viewing rights to specific cameras.
  3. Total required video storage is calculated on:
    - a. Minimum video compression: H.264
    - b. Maximum resolution for selected cameras
    - c. Minimum Frames Per Second: 10 FPS
    - d. Percentage of motion: 70%
    - e. Hours of active video: 24 hours
    - f. Duration of video storage: 30 days
    - g. Required storage space for future growth: 20%
  4. The Contractor shall furnish and install the required amount of video storage based off the criteria for calculations stated in the spec, section 2.01. D.
  5. Contractor shall coordinate with the Owner regarding setting up access to the system for individuals.
  6. The Contractor shall furnish camera licenses for all cameras provided on the project, and program all the associated DLK's (device license key) into the software to make the cameras operational.
  7. \* year \* software upgrade program shall be provided with each camera in the project.
  8. The field of views indicated on the construction plans are for general aiming direction only. The Contractor shall initially aim all cameras per Camera Schedule, and subsequent aiming per Owner's direction with the understanding that multiple trips to the camera for aiming will be required.
  9. The Contractor shall program all camera names into the system per Owner direction.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install surveillance systems cables and auxiliary materials as indicated in accordance with manufacturer's written instructions, and recognized industry practices.
  1. Contractor shall use hook and loop type fasteners on all security cable. Tie wraps shall not be used.

- B. Identify all cables as to field location.
  - 1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show cable identification. Install within 6" of cable end.
- C. After completion, all cables shall be thoroughly tested.
  - 1. Contractor shall provide all instruments for testing the cables.
  - 2. Contractor shall demonstrate in the presence of Owner's representative that the surveillance system is complete and operational.
  - 3. Contractor shall complete and submit the Certificate of System Demonstration.
- D. After completion, comprehensive As-Builts will be created and provided to Owner within 14 days.
  - 1. Two hard copies shall be provided to Owner detailing the entire security system after installation. Each field position shall be labeled and cross referenced to the appropriate head end position for ease of troubleshooting.

### **3.2 COMMISSIONING**

- A. The Contractor shall coordinate a date/time with the Engineer after the system is fully operational, but before final payment, for the Contractor to provide a full system demonstration. This shall include all aspects of system operation that the user might encounter.

**END OF SECTION 28 60 00**

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## **SECTION 28 80 00 – DISTRIBUTED ANTENNA SYSTEM (DAS)**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. The requirements of Division 00 - Procurement and Contracting Requirements, Division 01 - General Requirements and Section 28 00 10 – Electronic Safety and Security General Provisions are applicable to work required of this section.

#### **1.2 DESCRIPTION OF WORK**

- A. The work included under this specification consists of analysis for the implementation of a Distributed Antenna System for Public Safety/Emergency Responder use.
- B. It is not acceptable for any technical portion of this scope of work to be performed by anyone other than the Distributed Antenna System Contractor.

#### **1.3 SUBMITTALS**

- A. Results data from field testing.

#### **1.4 ACCEPTABLE DAS CONTRACTORS**

- A. The Contractor shall be qualified to provide a Two-Way Radio Communications Enhancement System for Public Safety use per requirements of 2020 NFPA 1221 Section 9.6
- B. The Contractor shall have a valid FCC-issued general radio operator's license per 2015 IFC Section 510.5
- C. The Contractor shall have certification by a nationally recognized organization, or certification issued by a manufacturer of Two-Way Radio Communications Enhancement System for Public Safety use, per 2015 IFC Section 510.5

### **PART 2 - PRODUCTS**

#### **1.5 DISTRIBUTED ANTENNA SYSTEM**

- A. Distributed Antenna System survey shall be implemented when construction nears a 75% completion. Wall assemblies, roof assemblies, windows and doors shall be installed prior to the survey occurring. Provide results of survey to Design Professional in a timely manner to address the installation of a DAS via change order to the project – or for work to be completed by a third-party Contractor outside the scope of this Contract.

### **PART 3 - EXECUTION**

#### **1.6 INSTALLATION**

- A. None.

**END OF SECTION 28 80 00**

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**DIVISION 31**



## SECTION 31 10 00 – SITE CLEARING

### PART 1 GENERAL

#### 1.1 WORK INCLUDED

- A. The CONTRACTOR shall provide all materials, labor, equipment and service necessary, for the completion of the work specified in this section.
- B. Removal and or transplanting of trees, shrubs, plant life and grasses as indicated on the construction documents within the project limits.
- C. Grubbing of any stumps or vegetation as indicated on the construction documents within the project limits.
- D. Removal of buildings, concrete, asphalt, existing utilities, and all fixed elements as indicated on the construction drawings.
- E. Coordinate all work within the right of way with the municipality.

### PART 2 PRODUCTS

Not Used

### PART 3 EXECUTION

#### 3.1 EXTENT OF WORK

- A. Site preparation work shall be performed over all of the area lying within the project limit lines.
- B. Prior to the start of demolition, site clearing activities and/or earthwork verify that perimeter erosion control measures are in place.

#### 3.2 CLEARING AND GRUBBING

- A. Clear all trees, vegetation, weeds, brush, roots, etc., lying within the project limits as indicated on the construction documents.
- B. Trees that are specified to remain shall be protected from construction activity and are indicated on the construction documents.
- C. It is intended that those areas that are to be undisturbed by construction remain as is, however, if disturbed, they must be returned to their existing condition prior to damage when construction is complete.

#### 3.3 OAK WILT

- A. Do not cut, prune or otherwise wound oaks in the spring or early summer, generally from April 15<sup>th</sup> through July 1<sup>st</sup>.
- B. Any activity during this period that cuts or tears through the bark and exposes live wood in oak trees shall have applied immediately and thoroughly pruning sealer or tree paint over the wound.
- C. Torn branches or roots should be cut clean and the cut surface painted. For additional treatment of the roots, after treating cover the exposed roots with soil.
- D. Should an oak tree be damaged, immediately notify the CONSTRUCTION MANAGER so the proper specialists can be consulted as to how to resolve the situation.

## SECTION 31 10 00 – SITE CLEARING

- E. Damage to oak trees indicated to remain shall be repaired and the proper preventative measure taken by the CONTRACTOR at no additional costs to the OWNER.

### 3.4 PROTECTION OF TREES

- A. Existing trees which are to remain are to be protected against construction activity. Do not smother trees by storing materials within the canopy line. Wire plank protection shall be placed around the trunks.
- B. If a tree scheduled to remain is destroyed by construction activity, the CONTRACTOR shall provide a tree of equivalent size and species or may be assessed a penalty not to exceed \$2,000.00. Any such assessment will be deducted from the contract sum by Change Order.

### 3.5 DEMOLITION

- A. Conduct demolition work with minimum interference to roads, streets, driveways, sidewalks, and other facilities including adjacent buildings, structures and their occupants.
- B. Sawcut all hard surfaces to provide a clear break line for new abutting surfaces to join at all locations indicated on the construction documents.
- C. Remove all fixed elements, hard surface areas, utilities, vegetation, miscellaneous items as indicated on the construction drawings.
- D. Take precautions to guard against movement, settlement or collapse of any surrounding structures indicated to remain and be liable for any such movement, settlement or collapse.

### 3.6 DISPOSAL OF WASTE MATERIAL

- A. Burning is not permitted on the OWNER'S property, unless authorization is obtained from the OWNER and the local governing Fire Department.
- B. Remove all organic and cleared vegetative matter from the site and dispose of in a legal manner.
- C. Remove all concrete, bituminous and debris from site and dispose of in a legal manner.

**END OF SECTION**

## SECTION 31 20 00 – EARTH MOVING

### PART 1 - GENERAL

#### 1.1 WORK INCLUDED

- A. The CONTRACTOR shall provide all materials, labor, equipment and services necessary for the completion of the work specified in this section.
- B. Salvaging Topsoil
- C. Unclassified Excavation
- D. Excavating, Backfilling, and Compacting for Structure
- E. Excavating, Backfilling, and Compacting for Utilities
- F. Excavating, Backfilling, and Compacting for Pavement
- G. Topsoil Placement
- H. Landscape Finish Grading

#### 1.2 REFERENCES

- A. ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures. Using 5.5 lb Rammer and 12" Drop.
- B. ANSI/ASTM D1556 - Test Method for Density of Soil in Place by Sand-Cone Method.
- C. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb Rammer and 18" Drop.
- D. State of Wisconsin Department of Transportation, Division of Highways Standard Specifications for Highway and Structure Construction, Current Edition.

#### 1.3 EXISTING CONDITIONS

- A. Known underground, surface, and aerial utility lines and buried objects are indicated on the drawings. Contact Digger's Hotline and the OWNER five (5) working days prior to start of demolition and construction.
- B. Locate all private utilities; coordinate with OWNER five (5) working days prior to the start of work.
- C. Hand expose existing utilities prior to start of work.

#### 1.4 SUBMITTALS

- A. Samples: Submit 25 lb sample of each type of fill to testing laboratory, in air-tight containers.

#### 1.5 RECORD DOCUMENTS

- A. Accurately record locations of utilities remaining, by horizontal dimensions, elevations or inverts, and slope gradients.

#### 1.6 UNIT PRICES

## SECTION 31 20 00 – EARTH MOVING

- A. Provide unit prices for the following items with bid (see bid form).
1. Over excavation of unsuitable soils (excavated, hauled and deposited) (Quantity shall be measured in-place).
  2. Granular fill (hauled, placed and compacted)(Quantity shall be measured in-place).
  3. Rock Blasting/Excavation (blast/excavate, hauled, exported) (Note: This unit price shall be for cubic yardage of rock blasting above the estimated 500 CY in base bid. Excavation for utility installation is not included in the 500 CY quantity, and shall be incidental to the utility installation.)

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Topsoil: On site excavated material consisting of loam, silt loam, silty clay loam, or clay loam humus-bearing adapted to sustain plant life. Topsoil shall be graded, free of roots, rocks larger than 1/4", subsoil, debris, and large weeds.
- B. Subgrade: Excavated material, graded, free of clumps larger than 6", rocks larger than 3", and debris.
- C. Granular Fill: Granular fill material, when required, shall consist of natural sand or a mixture of sand with gravel, crushed gravel, crushed stone or other broken or fragmented material. Granular fill shall meet the requirements of Section 209, Granular backfill of the Standard Specifications for Highway and Structure Construction.
- D. Stone Bedding: Stone for Class "B" bedding shall meet requirements of Section 608 Foundation Backfill of State of Wisconsin Department of Transportation, Division of Highways, Standard Specifications for Highway and Structure Construction, Current Edition.
- E. Dense Graded Base Course: Dense graded base course shall meet the requirements of Section 305, Dense Graded Base course of Standard Specifications for Highway and Structure Construction for D.O.T. 3/4" or 1-1/4" Gradation as per stated on design documents.

### PART 3 - EXECUTION

#### 3.1 SALVAGING AND SPREADING TOPSOIL

- A. Remove materials of horticultural value from topsoil prior to stripping.
- B. Disc existing two directions prior to stripping topsoil material.
- C. Strip topsoil; do not allow topsoil to be mixed with subgrade.
- D. Stockpile salvaged topsoil on site for future use.
1. Place silt fence around the base of the topsoil stockpile to prevent sediment runoff if piles withing 100 ft of property lines, waterways, drainage ways, public roads or streets and as per plans.

#### 3.2 UNCLASSIFIED EXCAVATION

- A. Excavating
1. Excavate in accordance with design grades and elevations.
  2. Do not perform additional excavation without prior written authorization of CIVIL ENGINEER/OWNER.
  3. Machine shape banks.
  4. Hand trim excavations to remove loose and/or organic matter.



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5. Fill over-excavated areas under structure bearing surfaces with stone bedding.
6. Do not disturb soil within canopy line of existing trees or shrubs that are to remain.
7. If necessary to excavate through canopy line, perform work by hand and cut roots encountered with a sharp axe.

### B. Overhaul

1. Haul excess material from site and dispose of in a legal manner.

### C. Granular Fill

1. Place fill materials in lifts not exceeding 9" in depth in accordance with design grades and contours.

### D. Rough Grading

1. Rough grade site to required contours and elevations as required for finish grading and surface treatment.
2. Prior to placing fill material over undisturbed subgrade surfaces, scarify to a minimum depth of 6".

## 3.3 EXCAVATING, BACKFILLING, AND COMPACTING FOR UTILITIES

### A. Preparation

1. Establish limits of excavation by area and elevation. Designate and identify datum elevation.
2. Set required lines and levels.
3. Maintain existing and established benchmarks, monuments, and other reference points.

### B. Utilities

1. Notify utility companies to adjust, relocate, and/or remove lines which are in the way of excavation.
2. CONTRACTOR shall be responsible for maintaining, adjusting, or relocating existing utility lines which are located in the work area. Costs exceeding those covered by utility companies shall be included in CONTRACTOR's bid.
3. Protect and maintain active utility services exposed by excavation.
4. Remove abandoned utility lines from areas of excavation. Cap, plug, or seal such lines and notify project CIVIL ENGINEER of such work completed.
5. Locate and record abandoned and/or active utility lines adjusted or relocated during construction with the project CIVIL ENGINEER.
6. Gas, electric (including main service, site lighting, conduits, and signage) cable, and telephone construction by others. Coordinate all earthwork activities with respective trades responsible for installation of said utilities.

### C. Excavation

1. Excavate in accordance with lines and grades indicated on the plan set documents.
2. Excavate trenches wide enough to enable proper installation of utilities and to allow for inspection. Trim and shape trench bottoms and leave free of irregular lumps and projections.
3. Do not disturb soil within canopy line of existing trees or shrubs that are indicated to remain. If it is necessary to excavate within the canopy line, perform work by hand and cut exposed roots with a sharp axe.
4. When complete with work, request CIVIL ENGINEER to inspect excavations. Correct unauthorized excavation as instructed by CIVIL ENGINEER at no additional cost to OWNER.
5. Stockpile excavated subsoil material for reuse on site. Remove excess or unsuitable excavated subsoil/ topsoil material from site and dispose of it in a legal manner unless otherwise stated on plans.

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### D. Dewatering Trenches

1. Provide equipment including pumps, piping, and temporary drains required to keep trenches dry during construction.
2. Do not discharge pumped water directly into municipal sewer systems without receiving prior approval. Ensure discharge water does not contain contamination or silt held in suspension.
3. Direct surface drainage away from excavated areas. Control grading in and adjacent to excavations to prevent water running into excavated areas or onto adjacent properties or public thoroughfares.
4. Furnish and operate pumping equipment on a twenty-four (24) hour basis if needed to keep excavated areas free of water until utilities have been placed and backfilled.

### E. Backfilling

1. All backfill material shall be on-site material unless granular fill is required by CIVIL ENGINEER/OWNER.
2. Do not start backfilling until utilities have been inspected by project CIVIL ENGINEER.
3. Ensure trenches are not in a frozen condition and are free of debris, snow, ice, or water.
4. Backfill as early as possible to provide time for natural settlement and compaction.
5. Place and compact backfill materials in lifts not exceeding 12". Use methods so as not to damage or disturb utilities.
6. Maintain optimum moisture content of backfill materials so as to attain required compaction density.
7. Remove excess backfill materials from site.

## 3.4 EXCAVATING, BACKFILLING, AND COMPACTING FOR ASPHALT/ CONCRETE PAVEMENT

### A. Excavation

1. Excavate the subsoil in accordance with grades and elevation required for completion of the work.

### B. Backfilling

1. Verify areas to be backfilled are not frozen and are free from debris, snow, ice, and water.
2. Do not backfill over existing subgrade materials which are wet or spongy.
3. Compact existing subgrade materials if densities are not equal to that specified for backfill materials.
4. Disc subgrade soil if needed to dry out any wet, soft, or spongy areas of existing subgrade in areas prior to base course or fill installation which do not pass loaded truck proof rolls. Discing operations for any one area may extend for 10 days. Days with excessive rain or poor drying conditions as determined by the engineer will not be counted towards the 10 days. Discing shall occur a minimum of once per day. Prior to the completion of the 10 days the contractor must provide the owner in written a request for additional cost to continue. Any additional discing required after 10 days must be approved by the owner before work proceeds.
5. Backfill as early as possible to provide time for natural settlement and compaction to occur.
6. Provide water if needed to maintain optimum moisture content of backfill materials to meet specified compaction density.

### C. Excavation Below Bituminous Paved/Concrete Areas Subgrade, Buildings Areas

1. Deposits of water-bearing soil, organic topsoil, and subgrade material containing considerable amounts of vegetable matter, or other unsuitable debris shall be removed from the area to receive paved surfaces to depths below the proposed finish grade shown on the plans, and/or as direction by the CIVIL ENGINEER. See GEOTECHNICAL BORING Report depicting any existing anticipated depths. Areas of excavation shall be backfilled with on-site suitable material if present. If said suitable material is not present, imported material (approved by CE) shall be imported as part of the base bid. The

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bottoms of such excavations shall be sloped and graded so that water does not pond in the bottoms of excavated areas.

2. Humus-bearing soils and other excavated materials not suitable for embankment construction shall be disposed of off site in a legal manner.
3. Overexcavation of unsuitable subgrade material discovered during construction under proposed asphalt/concrete areas not depicted on geotechnical report or plans shall be deemed as an extra cost.
4. Backfill required for over-excavation of areas discovered during construction under proposed asphalt/ concrete areas not depicted on geotechnical report or plans shall be clean non-organic fill, stone/ or granular material (approved by CE) and deemed as an extra cost.

### 3.5 TOPSOIL PLACEMENT AS FINISH GRADING

- A. Place topsoil in areas where seeding and/or sodding is required to a min thickness of 6" lightly compacted depth, unless otherwise noted on the plans.
- B. Place topsoil in relatively dry state, during dry weather.
- C. Finish grade topsoil eliminating rough or low areas while maintaining profiles and contour of subgrade and achieving required min 6" compacted depth.
- D. Remove roots, debris, rocks larger than 1/4" in size, weeds, and foreign material while spreading.
- E. Manually spread topsoil close to trees, fences, buildings, and other objects to prevent damage.
- F. Lightly compact topsoil after placement.
- G. Leave the stockpile area and site clean and ready for seeding, sodding, or other finish treatment.

### 3.6 PROTECTION

- A. Protect existing features remaining as part of final landscaping.
- B. Protect existing and established benchmarks, roads, sidewalks, paving, vegetation, and curbs against damage from equipment and vehicular or foot traffic.
- C. Protect excavation areas by shoring, bracing, sheet piling, underpinning, or other methods as needed to prevent cave-ins or loose dirt from falling into excavations.
- D. Secure adjacent structures prior to the start of excavation which may be damaged by excavation work, including utility lines and pipe chases.
- E. Notify CIVIL ENGINEER of unforeseen subsurface conditions encountered and discontinue work in the area until CIVIL ENGINEER provides notification to resume work.
- F. Grade around excavation areas to prevent surface water runoff into excavated areas resulting in pounding.

### 3.7 COMPACTION REQUIREMENTS

- A. Compact all subgrade below proposed bituminous/concrete pavement, and buildings areas, and all utility trenches, to 95% of the Standard Proctor. General green spaces shall be 85% of the

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Standard Proctor. If geotechnical report recommends more restrictive requirements those standards shall take precedence.

1. Proof roll testing shall also be performed using a fully loaded (20 US tons of material) tandem axle dump truck. The truck shall slowly drive back and forth at approximately 10'-15' wide intervals apart while the soils are evaluated for deflection / deformation below the rear tires. The truck shall cover the entire area being evaluated. Areas found to deflect more than approximately 1" in depth or leave permanent ruts of 2" or more will be evaluated by site engineer for potential subgrade improvements.

- B. The CONTRACTOR shall provide equipment capable of adding measured amounts of moisture to the soil material as determined by moisture-density tests. Where the subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply required amount of water to the surface of subgrade, or layer of soil material in such manner as to prevent free water from appearing on the surface during or subsequent to compaction operations. Remove and replace soil material that is too wet to permit compaction to 95% of maximum dry density, as established in accordance with ASTM-D1557.

### 3.8 COMPACTION TESTING

- A. Testing of compacted materials will be performed by an independent testing laboratory appointed and paid for by OWNER.
- B. The OWNER will pay for the cost of one series of tests for the area being evaluated. The CONTRACTOR shall pay for any additional testing costs as required due to improper performance of work.
- C. When work for this section or portions of work are completed, notify the testing laboratory to perform density tests. Do not continue with additional portions of work until test results have been verified.
- D. If, during progress of work, tests indicate that compacted backfill materials do not meet specified requirements, remove defective work, replace and retest at no cost to OWNER as directed by the CIVIL ENGINEER.
- E. Verify that compacted fills have been tested before proceeding with placement of surface materials.
- F. In-field testing shall be in accordance with ASTM D6938 "Density of Soil and Soil-Aggregate in Place by Nuclear Method." This test correlates to ASTM D-1556 "Density of Soil in Place by the Sand-Cone Method."
- G. The CONTRACTOR shall notify the testing laboratory and the CIVIL ENGINEER a minimum of forty-eight (48) hours in advance of the time compaction testing is required.

### 3.9 TOLERANCES

- A. Top surface of subgrade in proposed grassed areas: Plus or minus 1".
- B. Top surface of subgrade in proposed paved areas: Plus or minus 0.5".
- C. Finish grade of grass/lawn areas: Plus or minus 0.5".

### 3.10 FIELD QUALITY CONTROL

## **SECTION 31 20 00 – EARTH MOVING**

- A. Testing of granular fill and backfill materials will be performed by an independent testing laboratory appointed and paid for by the OWNER.
- B. The OWNER will pay for the cost of one series of tests on areas being inspected. The CONTRACTOR will pay for costs of additional testing required due to improperly performed work.
- C. Tests and analysis of fill material shall be performed in accordance with ANSI/ASTM D698 D1557.
- D. Compaction testing shall be performed in accordance with ANSI/ASTM D1556, ANSI/ASTM D1557, ANSI/ASTM D6938.
- E. If testing indicates that the work does not meet specified requirements, remove work, replace and retest at no cost to OWNER.

### **3.11 UTILITY LOCATES**

- A. All required Diggers Hotline locates and private utility locates shall be ordered and paid for by each contractor requiring the locate service.

**END OF SECTION**

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## SECTION 31 23 00 - FOUNDATION EXCAVATING AND BACKFILLING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Foundation, excavating, and backfilling within five feet of the building perimeter. Work shall include, but not be limited to, the following items:
  - 1. Removal of all unacceptable soil.
  - 2. Furnish and install acceptable fill.
  - 3. Prepare subgrade for footings and slab on grade.
- B. The following items are not a part of this specification:
  - 1. Utility trenching and related backfilling outside the building footprint.
  - 2. Subgrade for exterior walks and paving.
- C. Structural notes indicated on the drawings regarding foundation excavating and backfilling shall be considered part of this specification.

#### 1.2 RELATED WORK

- A. Pertinent Sections of Division 01.
- B. Pertinent Sections of Division 31.

#### 1.3 REFERENCES

- A. Codes and Standards: Comply with the provisions of the following codes, specifications and standards, except where more stringent requirements are shown or specified. Where any provisions of other pertinent codes and standards conflict with this specification, the more stringent provision shall govern.
  - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 2. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
  - 3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using the Modified Effort.
  - 4. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  - 5. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
  - 6. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
  - 7. ASTM D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
  - 8. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  - 9. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
  - 10. Wisconsin Department of Transportation (WisDOT): WisDOT Standard Specifications for Road and Bridge Construction.

#### 1.4 TESTING

##### A. Minimum testing frequency and locations:

###### 1. Laboratory Testing:

- a. Granular fill: One representative gradation test for each type of material.
- b. Cohesive soils: One representative set of Atterberg limits and moisture density test for each type of material used.
- c. Non-cohesive soils: One representative moisture density test for each type of material used.

###### 2. Field Testing:

- a. The Inspector shall determine the location of testing.
- b. Testing of final utility trench backfill shall begin at a depth of 2 feet above the top of the pipe.
- c. In-place field density test and moisture content tests shall be performed as follows:
  - 1) Fills not within the influence of building foundations and slab on grade: Per civil specifications.
  - 2) For fills within the influence of building foundations and slab on grade, the following criteria shall apply: One test for each 8-inch vertical lift of compacted fill placed per 2,500 square feet of fill area (minimum of two tests per lift per structure for areas smaller than 5,000 square feet).
- d. Additional testing may be required by the Inspector if noncompliance or a change in conditions occurs.
- e. If a test fails, the Contractor shall rework the material, recompact and retest as necessary until specific compaction is achieved in all areas of the trench. All costs associated with this work, including retesting, shall be the responsibility of the Contractor.

#### 1.5 SUBMITTALS

- A. Material Test Reports: Provide the Owner and Architect with the on-site material test reports from the Inspection Agency indicating the interpreting test results for compliance with this specification.

#### 1.6 PROTECTION

- A. Contractor shall provide for design, permits and installation of all cribbing, bracing, shoring and other methods required to safely retain earth banks and excavations.
- B. Notify the Architect immediately and discontinue work in affected area if adjacent existing footings are encountered during excavation. Underpin other adjacent structures that may be damaged by excavation work, including service utilities and pipe chases.
- C. Notify the Architect of unexpected subsurface conditions and discontinue work in affected areas until notification to resume.
- D. Protect benchmarks, existing structures, fences, sidewalks, paving, curbing, etc., from excavation equipment and vehicular traffic.
- E. Maintain and protect above and below grade utilities that are to remain.



- F. Provide temporary heating or protective insulating materials to protect subgrades and foundations soils against freezing temperatures or frost during cold weather conditions.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. General: Provide borrow soil materials when sufficient acceptable soil materials are not available from excavations.
- B. Acceptable soils shall comply with the following:
  1. Meet ASTM D2487 soil classification groups GW, GP, GM, SW, SP, SM or a combination of these group symbols.
  2. Be free of rock or gravel larger than 3 inches in any dimension.
  3. Be free of debris, waste, frozen materials, vegetation and other deleterious materials.
  4. Have a liquid limit less than 45 and a plasticity index less than 20.
  5. Be approved by the Inspection Agency.

- C. Unacceptable soils shall be defined as following:
  1. ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, PT or a combination of these group symbols.
  2. Unacceptable soils also to include acceptable soils not maintained within 2 percent of optimum moisture content at time of compaction.

- D. Free-Draining Granular Fill: Free-draining granular fill shall comply with the following:
  1. Be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone.
  2. Be clean and free of fines.
  3. Comply with ASTM D2940.
  4. Be uniformly graded as follows:

Coarse Aggregate Gradations						
Sieve Size - Percent Passing						
Grade No.	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4
CA7	100	95 ± 5	-	45 ± 15	-	5 max

- 5. Be approved by the Inspection Agency.
- E. Engineered Fill and Utility Base Course shall comply with the following:
  1. Be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, natural or crushed sand.
  2. Comply with ASTM D2940.
  3. Be uniformly graded as follows:

Coarse Aggregate Gradations						
Sieve Size - Percent Passing						
Grade No.	1-1/2"	1"	1/2"	No. 4	No. 16	No. 200
CA6	100 to 90	95 ± 5	75 ± 15	43 ± 13	25 ± 15	8 ± 4

- 4. Be approved by the Inspection Agency.

- F. Material Applications: Provide and install material meeting with the above requirements as follows:
1. General fill: Acceptable soils.
  2. Backfill against basement and retaining walls for 2 feet directly adjacent to wall: Free-draining granular fill.
  3. Backfill at over-excavated areas beneath footings: Engineered fill.
  4. Sub-grade layer beneath slabs-on-grade: Refer to drawings.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Identify and verify required lines, levels, contours and benchmark elevations for the work are as indicated.
- B. Protect plant life, lawns, other features and vegetation to remain as a portion of the final landscaping.
- C. Free groundwater is not expected during excavation. Contractor shall provide for de-watering of excavations from surface water, ground water or seepage. Where ground water occurs during excavation, special procedures shall be implemented as recommended by the Geotechnical Engineer of Record.
- D. Identify known underground utility locations with stakes and flags.

#### **3.2 EXCAVATION**

- A. All excavations shall be safely and properly backfilled.
- B. All abandoned footings, utilities and other structures that interfere with new construction shall be removed.
- C. All unacceptable material and organic material shall be removed from below all proposed slabs-on-grade and the exposed natural soil shall be proof rolled and the compaction verified by the soils testing firm prior to placing fill. Proof-roll with a loaded tandem dump truck, loaded ready-mix truck, roller, or equivalent weight vehicle. Materials exhibiting weakness, such as those exhibiting rutting or pumping, shall be removed and replaced with acceptable compacted fill material.
- D. Do not excavate within the 45-degree bearing splay of any adjacent foundations.
- E. Remove lumped subsoil, boulders and rock up to 1/3 cubic yard (measured by volume). Provide Owner with unit price per cubic yard for obstructions larger than 1/3 cubic yard.
- F. Outside 45-degree bearing splay of foundations, correct areas over excavated with aggregate at no additional cost to the Owner.
- G. Within the 45-degree bearing splay of foundations, correct areas over excavated with 2000 psi concrete fill at no additional cost to the Owner. Notify the Architect prior to performing such work.
- H. Hand trim final excavation to remove all loose material.

- I. Contractor shall form all dams and perform other work necessary for keeping the excavation clear of water during the progress of the work and, at Contractor's expense, shall pump or otherwise remove all surface and perched water which accumulates in the excavations. Perched water that cannot be de-watered in 48 hours of continuous pumping at a minimum rate of 60 gpm in dry weather shall be considered ground water.
- J. Stockpile excavated material in the area designated and remove excess material not being used, from the site.

### 3.3 BACKFILLING

- A. Verify foundation perimeter drainage system is complete and has been inspected prior to backfilling against foundation walls.
- B. Support pipe and conduit during placement and compaction of bedding fill.
- C. Systematically backfill to allow necessary time for natural settlement. Do not backfill over porous, wet, spongy, or frozen subgrade surfaces.
- D. Backfill areas to contours and elevations with unfrozen materials.
- E. Unless noted otherwise on the drawings, make grade changes gradual.
- F. Unless noted otherwise on the drawings, slope grade away from the building a minimum of 2 inches in 10 feet.
- G. Contractor shall procure the approval of the subgrade from the Inspection Agency prior to the start of any filling or bedding operations.
- H. Place a minimum width of 24 inches of free-draining granular fill against all basement and retaining walls for the full height of the wall.
- I. Do not begin any backfill operations against any concrete walls until the concrete has achieved its specified strength.
- J. Do not backfill against below grade walls until supporting slab or framing is installed and has been anchored to the wall per the drawings.
- K. Place and mechanically compact granular fill in continuous layers not to exceed 8 to 10 inches loose fill depth.
- L. Employ a placement method that does not disturb or damage adjacent utilities, vapor barriers, foundation perimeter drainage and foundation waterproofing.
- M. All surplus fill materials are to be removed from the site.
- N. Fill material stockpiles shall be free of unacceptable soil materials.
- O. After work is complete, remove all excess stockpile material and repair stockpile area to its original condition.

### 3.4 COMPACTION

- A. Compact all fill that will support building footings or floor slabs to 95 percent of the maximum dry density in accordance with ASTM D698. For relative cohesionless fill materials, where the percent passing the #200 sieve is less than 10 and the moisture density curve indicates only slight sensitivity to changing moisture content, compaction requirements should be changed to 75 percent relative density in accordance with ASTM D4253 and ASTM D4254.
- B. Compact all fills that support paving and landscape per civil specifications.

### 3.5 FOUNDATIONS

- A. Each footing excavation should be cleared of all obstructions and other organic or deleterious materials.
- B. Localized areas of unstable or unacceptable material may be discovered during the stripping and excavation operation and may require over-excavation and backfilling. The Inspection Agency shall be present during the proof rolling to evaluate any localized areas and make recommendations regarding over-excavation, backfilling and recompaction of these areas. Fill placement and compaction shall be inspected and tested by the Inspection Agency.
- C. Footing elevations shown on the drawings designate a minimum depth of footing where an appropriate soil bearing pressure is expected. Footings, piers and/or walls shall be lowered or extended as required to reach soil meeting the design bearing pressure. This work shall be performed per the recommendations of the Inspection Agency.
- D. All footing excavations shall be recompacted by hand-operated, vibratory compaction equipment, except where compaction will degrade the integrity of subgrade soils. In these instances, bottom of footing excavations should be hand-trimmed to remove loosened material.
- E. All excavation and recompacted surfaces shall be inspected and tested to a depth of 2.0 feet below the excavated elevation by the Inspection Agency. Additional field density tests should be performed for each one foot of fill material placed. Any areas not in compliance with the compaction requirements should be corrected and re-tested prior to placement of fill material.
- F. For foundation areas where over excavation is performed, place and mechanically compact Engineered fill material in continuous layers not to exceed 8 to 10 inches loose fill depth.

### 3.6 SLAB-ON-GRADE

- A. All disturbed areas after the clearing and stripping operation should be proof-rolled and recompacted with a heavy vibratory drum roller (approved by the Inspection Agency) in the static mode. The compactor should make a minimum of 10 passes, with a minimum of one foot overlap of each pass. The compactor speed should be less than 0.2 MPH.
- B. The Inspection Agency shall monitor proof-rolling and compaction operations. This area should then be tested for compaction to a depth of 2.0 feet below the compacted surface prior to the placement of any structural fill material.
- C. Refer to drawings for required sub-grade preparation beneath slabs-on-grade.

### 3.7 UTILITY TRENCH BACKFILL (AT SLAB-ON-GRADE LOCATIONS)

- A. Excavate and backfill utility trenches under wall footings as shown on the drawings.

- B. Place utility base course on subgrades free of mud, frost, snow, or ice.
  - C. Place and compact utility base course on trench bottoms and where indicated.
  - D. Lay underground utilities on 6" sand bedding, which meets the acceptable criteria of Section 2.1B.
  - E. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
  - F. After connection joints are made, any misalignment can be corrected by tamping the sand around the utilities.
  - G. Place and compact initial backfill of acceptable sand to a height of 6 inches over the utility pipe or conduit in 6 inch layers meeting specified compaction requirements.
  - H. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit.
  - I. Place and compact final backfill using acceptable soil to final subgrade elevation meeting specified compaction requirements.
  - J. Backfill voids with acceptable soil while installing and removing shoring and bracing.
  - K. Inspection Agency shall monitor and test compacted backfill to verify final compaction meets the specified requirement.
- 3.8 TOLERANCES
- A. Top surface of backfilling under paved areas: Plus or minus 1/2 inch from required elevation.
  - B. Top surface of general backfilling: Plus or minus 1 inch from required elevation.

END OF SECTION

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## SECTION 31 25 00 – EROSION CONTROL

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. The CONTRACTOR shall provide all materials, labor, equipment and services necessary for the completion of the work specified in this section.
- B. Placement and removal of silt fence.
- C. Placement of erosion control blankets/turf reinforcement.
- D. Installation of sediment tracking construction entrance.
- E. Placement, cleaning, and removal of inlet protection.
- F. Placement and removal of log-type ditch check slope interruption products.

#### 1.2 RELATED SECTIONS

- A. Section 311000 – Site Clearing
- B. Section 312000 – Earthmoving
- C. Section 334100 – Storm Utility Drainage Piping

#### 1.3 REFERENCES

- A. State of Wisconsin Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition.
- B. Wisconsin Department of Natural Resources Storm Water Construction and Post-Construction Technical Standards.
- C. State of Wisconsin Department of Transportation, Erosion Control Product Acceptability List for Multi-Modal Applications (PAL), Current Edition
- D. Village of Bonduel Municipality Code

#### 1.4 REQUIREMENTS

- A. CONTRACTOR shall provide and secure all erosion control permits from all governing authorities not previously obtained by the OWNER.
- B. The OWNER shall obtain the WDNR/WPDES Notice of Intent: The CONTRACTOR shall abide by the requirements set in the Notice of Intent (NOI). A copy may be acquired from the ARCHITECT.
- C. Erosion control measures shall be installed as indicated on the project construction documents and abiding with requirements of the Wisconsin Storm Water Construction and Post-Construction Technical Standards.
- D. Including but not limited to the WDNR/WPDES Notice of Intent (N.O.I.).

## SECTION 31 25 00 – EROSION CONTROL

### PART 2 - PRODUCTS

#### 2.1 EROSION CONTROL BLANKETS

- A. Erosion control blankets for non-channel use shall meet the requirements in Standard 1052 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.
- B. Erosion control blankets for non-channel, slopes use shall be on the Wisconsin Department of Transportation's PAL for Class I Erosion Mats, Type B. See Plans

#### 2.2 SILT FENCE

- A. Silt Fence shall meet the requirements in Standard 1056 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.
- B. Silt Fence shall have Wisconsin Department of Transportation PAL Type FF, geotextile fabric.

#### 2.3 SEDIMENT TRACKING CONSTRUCTION ENTRANCE

- A. Sediment tracking construction entrance shall meet the requirements in Standard 1057 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.

#### 2.4 INLET PROTECTION

- A. Inlet Protection shall meet the requirements in Standard 1060 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.
- B. Inlet Protection shall have Wisconsin Department of Transportation PAL Type FF, geotextile fabric.

#### 2.5 SLOPE INTERRUPTION PRODUCTS

- A. Interim Manufactured Perimeter Control and Slope Interruption Products, including bio-log style products, shall meet the requirements in Standard 1071 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF EROSION CONTROL BLANKET

- A. Install Erosion Control blanket in accordance with Standard 1052 and 1053 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.
- B. Refer to manufacturer's recommendations and detail drawings for additional installation information.

#### 3.2 INSTALLATION OF SILT FENCE

- A. Install silt fence in accordance with Standard 1056 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.

#### 3.3 SEDIMENT TRACKING CONSTRUCTION ENTRANCE

- A. Install sediment tracking construction entrance in accordance with Standard 1057 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.



## **SECTION 31 25 00 – EROSION CONTROL**

### **3.4 INLET PROTECTION**

- A. Install inlet protection in accordance with Standard 1060 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.

### **3.5 SLOPE INTERRUPTION PRODUCTS**

- A. Install log-type product in accordance with Standard 1071 in the Wisconsin Storm Water Construction and Post-Construction Technical Standards.

### **3.6 NOTICE OF INTENT**

- A. The PROJECT CIVIL ENGINEER, on behalf of the OWNER, has submitted to the Wisconsin Department of Natural Resources, the Notice of Intent (NOI). It is the responsibility of the CONTRACTOR to perform all work in accordance with the WPDES Permit No. WI-S067831-5 Permit. A copy may be obtained from the A/E upon request.

### **3.7 ONGOING INSPECTIONS**

- A. Inspect and document all inspections of erosion control elements for the required NOI documentation.
- B. The Contractor shall use Form 3400-187 (R 11/16) for inspection documentation.

### **3.8 NOTICE OF TERMINATION**

- A. Upon the completion of the project, and achieving 70% stabilization, complete the Notice of Termination (NOT), and submit as required to the Wisconsin Department of Natural Resources.

**END OF SECTION**

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**DIVISION 32**



## SECTION 32 11 23 – AGGREGATE BASE COURSES

### PART 1 GENERAL

#### 1.1 WORK INCLUDED

- A. The CONTRACTOR shall provide all materials, labor, equipment and services necessary for the completion of the work specified in this section.
- B. Furnish, place and compact dense graded base course for pavement as indicated on construction documents.
- C. Furnish and install soil separation fabric as indicated on construction drawings.

#### 1.2 REFERENCES

- A. State of Wisconsin Department of Transportation, Division of Highways Standard Specifications for Highway and Structure Construction, Current Edition.
- B. Geotechnical Report provided.

### PART 2 - PRODUCTS

#### 2.1 DENSE GRADED BASE COURSE

- A. Dense graded base course shall meet Section 305 Base Aggregate Dense  $\frac{3}{4}$  inch, 1  $\frac{1}{4}$  Inch, and 3 inch of Standard Specifications for Highway and Structure Construction.
- B. Tolerances

Finish grade shall not vary from any plan grade at any location by the following:

1. Dense Grade Base Course: 1/4"

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Place material meeting requirements of Section 305 of Standard Specifications for Highway and Structure Construction, Current Edition, State of Wisconsin Department of Transportation, Division of Highways.
- B. Compact material meeting Special Compaction Requirements of Section 305 of Standard Specifications for Highway and Structure Construction, Current Edition, State of Wisconsin Department of Transportation, Division of Highways.
- C. Remove surplus material from site and dispose of in a legal manner.

**END OF SECTION**

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## SECTION 32 13 13 – PORTLAND CEMENT CONCRETE PAVING

### PART 1 GENERAL

#### 1.1 WORK INCLUDED

- A. Exterior concrete for:
  - 1. Paving/Slabs
  - 2. Concrete sidewalks
  - 3. Concrete Curb
- B. Reinforcement
- C. Surface finish.
- D. Curing.

#### 1.2 RELATED WORK

- A. Section 32 11 23 – Aggregate Base Course.

#### 1.3 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Obtain materials from same source throughout.
- C. Regulatory Requirements:
  - 1. Construct ramps and curb ramps in accordance with Americans with Disabilities Act.

#### 1.4 SUBMITTALS

- A. Submittals:
  - 1. Proposed Mix Design for review prior to commencement of work.
  - 2. Prior to any concrete work being performed, the contractor must provide an on site reference sample to be used for acceptance of workmanship and finish. Samples shall be large enough to represent all finishing that apply, including but not limited to joints, saw cuts, brooming, coloring and stamping. In Lieu of an onsite sample, the contractor may provide a recently finish project within the municipality or at a reasonable distance from the project, as determined by the owner, to be used as a reference site.
  - 3. Product data: manufacturer's specifications and installation instructions for Detectable warnings for curb ramps.

#### 1.5 TESTS

- A. Submit proposed mix design for review prior to commencement of work.
- B. Test Reports: Reports in accordance with requirements specified in Article 3.9D, Field Quality Control.

### PART 2 PRODUCTS

#### 2.1 CONCRETE MATERIALS

- A. Portland Cement: Type I conforming to ASTM C 150, "Standard Specification for Portland Cement".
- B. Normal Weight Aggregates: Conforming to ASTM C 33 "Standard Specification for Concrete Aggregate." Aggregates not complying with this standard may be used providing it can be shown by special test or a record of past performance that these aggregates produce concrete of adequate strength and durability.
- C. Fine aggregate: clean, natural sand, free from loam, clay lumps or deleterious substances. Fineness modulus of sand shall have a minimum value of 2.3 and a maximum value of 3.0.

## SECTION 32 13 13 – PORTLAND CEMENT CONCRETE PAVING

- D. Coarse aggregate:
    - 1. Crushed and graded limestone containing no clay, mud, loam or foreign matter.
    - 2. Native aggregate from a D.O.T.-approved source pit or quarry may be used in lieu of limestone.
    - 3. Limit to 1% of the coarse aggregate by weight the amount of chert with a specific gravity less than 2.40 in exposed concrete.
    - 4. Coarse aggregate shall be nominal maximum sizes of 3/4", conforming to ASTM C33, Table 2.
  - E. Water: shall be clean and free from deleterious materials.
  - F. Curing Compounds: Conforming to ASTM C-309, Type 1, Class A, clear or translucent without fugitive dye; Wax or saponifiable resin types are not approved.
    - 1. Curing compounds shall exceed the moisture retention requirements of ASTM C309, when tested in accordance with ASTM C156 at the maximum coverage rate recommended by the manufacturer.
  - G. C309, when tested in accordance with ASTM C156 at the maximum coverage rate recommended by the manufacturer.
    - 1. Approved Products:
      - a. "Masterseal" by Master Builders
      - b. "1100 Clear" by W.R. Meadows
      - c. "Tri-Kote 26" by T. K. Products
    - I. Integral Color concrete agent if required as manufactured County Materials Corporation, Marathon, WI or Equally approved
- 2.2 REINFORCEMENT (When Noted)
- A. Welded Steel Wire Fabric: ASTM A185 plain type; in flat sheets; uncoated finish.
  - B. Fibermesh 300 homopolymer polypropylene fibrillated fibers. Apply at 1.5 lbs/yd<sup>3</sup>
- 2.3 DESIGN
- A. Provide concrete mix with the following properties:
    - 1. Compressive Strength: 4,000 psi at 28 days
    - 2. Slump: 2" to 4"
    - 3. Maximum water to cementitious material (cement plus fly ash) ratio: 0.45.
    - 4. Minimum cement plus fly ash content: 520 lbs. per cubic yard
    - 5. Total air content required (air-entrained and entrapped air): 6% +/- 1.5%.
- 2.4 ACCESSORIES
- A. Preformed Joint Filler: ASTM D1751, asphalt impregnated fiber board. Provide filler throughout the slab depth and of 1/2" thickness.
  - B. Detectable Warnings for Curb Ramps: Mat with truncated domes complying with Americans with Disabilities Act; provide fasteners and adhesives as recommended by mat manufacturer.
    - 1. Recycled Tire Core: Nylon and Rayon fibers mixed into rubber composite.
    - 2. Slip resistant surface.
    - 3. Perimeter beveled-edge.
    - 4. Provide fasteners, sealers, and adhesives as recommended by mat manufacturer.



## SECTION 32 13 13 – PORTLAND CEMENT CONCRETE PAVING

### PART 3 EXECUTION

#### 3.1 GENERAL

- A. Place material meeting requirements of Section 305 of Standard Specifications for Highway and Structure Construction, Current Edition, State of Wisconsin Department of Transportation, Division of Highways.
- B. Compact material meeting Special Compaction Requirements of Section 305 of Standard Specifications for Highway and Structure Construction, Current Edition, State of Wisconsin Department of Transportation, Division of Highways.
- C. Remove surplus material from site and dispose of in a legal manner.

#### 3.2 INSPECTION

- A. Verify compacted granular base is ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. Beginning of installation means acceptance of existing conditions.

#### 3.3 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Notify ARCHITECT a minimum 24 hours prior to commencement of concreting operations.

#### 3.4 FORMING

- A. Place and secure forms to correct location, dimension, and profile.
- B. Place joint fillers vertical in position, in straight lines. Secure to formwork during concrete placement.

#### 3.5 REINFORCEMENT

- A. Place reinforcement at top third height of slabs-on-grade.
- B. Interrupt reinforcement at all joints.

#### 3.6 FORMED JOINTS

- A. Place expansion joints in sidewalks every 400 square feet with a maximum 40 ft. o.c. spacing.
- B. Place expansion joints in curb and gutter at 40 ft. o.c.
- C. Place expansion joints between curbs and walks.
- D. Place joint filler in expansion joints and between curbs and walks, between paving components and building, and at catch basins, manholes, and other appurtenances.
- E. Provide scored or sawn control joints unless otherwise specified on plans. Joints shall be at right angles to the edges of work.
  - 1. Where walks are wider than 8'-0" provide longitudinal joints as directed.
  - 2. Space control joints per plan or if not stated at 5 foot intervals for sidewalks.
  - 3. Space control joints at 10 feet intervals for curbs.
  - 4. Place control joints in flat work every 100 square feet with maximum 10 ft. spacing.
  - 5. All panels should be square or nearly so. The length should not exceed 1.5 times the width.

## SECTION 32 13 13 – PORTLAND CEMENT CONCRETE PAVING

- F. Align curb, gutter, and sidewalk joints.
  - G. Place construction joints at the end of all pours and at locations where placement operations are stopped for more than 1/2 hour. If the construction joint will also be an expansion joint, dowel and sleeve the reinforcement.
- 3.7 PLACING CONCRETE
- A. Place concrete in accordance with ACI 301.
  - B. Tolerances  
Finish grade shall not vary from plan grade at any location by the following:
    - 1. Concrete walks/flat work: 1/8"
    - 2. Concrete curbs and gutter: 1/8"
  - C. Sawcuts and/or tooled joints shall not vary more than 1" off a straight line pulled in 50' of length.
  - D. If the concrete surface or joint line varies more than the allowed tolerance, it will be at the discretion of the CIVIL ENGINEER/or Owner whether the concrete section shall be removed and replaced.
- 3.8 FINISHING
- A. After striking off and consolidating concrete, smooth the surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust the floating to compact the surface and produce a uniform texture.
  - B. Provide positive slope on concrete surfaces to provide drainage.
  - C. After floating, test surface for trueness with a 10' straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous, smooth finish.
  - D. Work edges of walks and joints with a 1/4" radius edging tool. and a 4" wide smooth troweled surface at edges; provide broom finish on remainder of surface.
  - E. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing by drawing a fine-hair broom across the concrete surface, perpendicular to the line of traffic. Repeat operation if required to provide a fine line texture acceptable to the A/E.
- 3.9 CURING/PROTECTION
- A. Use curing methods and provide protection as required.
  - B. Apply Curing Compound uniformly in continuous operation by power-spray or roller in accordance with manufacturer's instructions.
    - 1. Recoat areas subjected to heavy rainfall occurring within 3 hours after initial application.
    - 2. Maintain continuity of coating and repair damage during curing period.
  - C. Immediately after placement, protect concrete from premature drying, excessive hot or cold temperatures, and mechanical injury.
  - D. Exclude traffic from concrete for at least 14 days after placement. When construction traffic is permitted, maintain the work as clean as possible and remove surface stains and spillage of materials as stains and spillages occur.
- 3.10 FIELD QUALITY CONTROL
- A. Materials and operations shall be tested and inspected as work progresses. Failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate the owner for final acceptance.

## SECTION 32 13 13 – PORTLAND CEMENT CONCRETE PAVING

- B. Testing agencies shall meet the requirements of "Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction", ASTM E 329.
- C. The following testing services shall be performed by the testing agency and shall be paid for by the Owner. Any additional testing due to failing results will be paid for by the Contractor.
  - 1. Secure composite samples in accordance with "Standard Method of Sampling Fresh Concrete," ASTM C 172.
- D. Fresh Concrete," ASTM C 172.
  - 1. Mold and cure four cylinders from each test required in accordance with "Standard Method of Making the Curing Concrete Test Specimens in the Field," ASTM C 31.
  - 2. Test cylinders in accordance with "Cylindrical Standard Test Method for Compressive Strength of Concrete Specimens," ASTM C 39. Two cylinders shall be tested at 28 days for acceptance and one shall be tested at 7 days and one at 14 days for information.
  - 3. Make one set of cylinders for each 50 cubic yard or 5000 square feet of wall or floor surface or fraction thereof, of each mix design of concrete placed in any one day.
  - 4. A record shall be made by a representative of the general contractor of the
- E. Delivery ticket number for the particular load of concrete tested and the approximate location in the work at which each load represented by a strength test is deposited.
  - 1. Determine total air content of normal-weight concrete sample for each strength test in accordance with "Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method," ASTM C231 or "Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method", ASTM C173.
  - 2. Submit one copy of all test data to a/e and the concrete supplier within 3 days of tests.

**END OF SECTION**

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## SECTION 32 13 75 – PAVEMENT JOINT SEALANTS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Sealant for:
  - 1. Joints in cement concrete sidewalks.
  - 2. Joints between cement concrete sidewalks, stoops, and other construction.

#### 1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Qualification Data: For Installer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Trained and approved in writing by Manufacturer.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single Manufacturer.
- C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a three (3) year period preceding the commencement of the Work.
- D. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers with labels indicating Manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials to comply with Manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

#### 1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
- B. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
- C. When joint substrates are wet or covered with frost.
- D. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
- E. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application indicated, as demonstrated by joint-sealant Manufacturer based on testing and field experience.

## SECTION 32 13 75 – PAVEMENT JOINT SEALANTS

- B. Joint Sealant: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
- C. Products: Subject to compliance with requirements, provide one of the following:
  - 1. Crafcoc Inc.; RoadSaver Silicone SL.
  - 2. Dow Corning Corporation; 890-SL.
  - 3. Approved Substitute
- D. Joint-Sealant Backer: Non-staining; compatible with joint substrates, sealants, primers, and other joint fillers and approved for applications indicated by joint-sealant Manufacturer based on field experience and laboratory testing.
- E. ASTM D 5249, Type 3, of diameter and density required to control sealant-depth and to prevent bottom-side adhesion of sealant.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants for compliance with Manufacturer's requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

#### 3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant Manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- D. Do not leave gaps between ends of backer materials.
- E. Do not stretch, twist, puncture, or tear backer materials.
- F. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- G. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - H. Place sealants, so they directly contact and fully wet joint substrates.
  - I. Completely fill recesses provided for each joint configuration.
  - J. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
  - K. Provide recessed joint configuration to comply with joint-sealant Manufacturer's written instructions, unless otherwise indicated.

#### 3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by Manufacturers of joint sealants and of products in which joints occur.

## **SECTION 32 13 75 – PAVEMENT JOINT SEALANTS**

### **3.5 PROTECTION**

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage so sealants are without deterioration or damage at time of Substantial Completion. Cut out and remove damaged or deteriorated joint sealants. Install new joint sealant so repairs are indistinguishable from original work.

**END OF SECTION**

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## SECTION 32 17 23 – PAVEMENT MARKINGS

### PART 1 GENERAL

#### 1.1 SCOPE OF WORK

- A. The CONTRACTOR shall provide all labor, materials, equipment and service necessary, or incidental, to the completion of the work specified in this section.
- B. Crosswalk striping
- C. Parking lot striping

#### 1.2 QUALITY ASSURANCE

- A. Work in this section shall be completed by workmen skilled and experienced in the application of pavement markings on bituminous surfaces. Submit to the ARCHITECT evidence of five (5) years of experience. List projects of a similar scope.

#### 1.3 JOB CONDITIONS

- A. Verify with the asphaltic paving contractor that the surface on which the markings are to be applied has cured and is ready to be striped.
- B. Observe the environmental precautions regarding temperature and humidity in the application of the line marking paint. Delay applications when drying conditions will not allow the paint materials to dry in a timely manner.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Paint shall be waterborne or solvent borne, colors as shown or specified herein.  
Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the Local Air Pollution Control District.
- B. Waterborne Paint: Paints shall conform to FS TT-P-1952
- C. Solvent Borne Paint: Paint shall conform to FS A-A-2886 or AASHTO M248. Paint shall be non-bleeding, quick-drying, and alkyd petroleum base paint suitable for traffic-bearing surface and be mixed in accordance with manufacture's instructions before application for colors White.

### PART 3 EXECUTION

#### 3.1 LAYOUT

- A. Do not apply paint until paving has cured a minimum of 14 days.
- B. Use steel tapes, transits, and other surveying equipment which will allow the precise measurement of distances and angles.
- C. Perform layout with chalk or lumber crayon only.
- D. Remove grease, oil, dirt, or other surface contaminants which would affect the appearance or performance of the painting work.

#### 3.2 APPLICATION

- A. Install pavement markings according to the manufacture's recommended procedures for the specified material.
- B. Tolerances:
  - 1. General: Make lines parallel, evenly spaced, and with sharply defined edges.
  - 2. Line Widths:
    - a. Plus or minus 1/4 inch variance on straight segments.
    - b. Plus or minus 1/2 inch variance on curved alignments.

## SECTION 32 17 23 – PAVEMENT MARKINGS

C. Protect completed work from damage.

### 3.3 CLEANING

A. Remove drips, overspray, improper markings, and paint material tracked by traffic by sand blasting, wire brushing, or other methods approved by architect.

**END OF SECTION**

## SECTION 32 33 00 – SITE FURNISHINGS

### PART 1 GENERAL

#### 1.1 WORK INCLUDED

- A. The Contractor shall provide all labor, materials, equipment, and services necessary, or incidental to the completion of the work specified in this section.
- B. Installation of Accessible parking space signs and other traffic signs.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Accessible Parking Space Sign-
  - 1. 18"x12", M.U.T.C.D. R7-8, aluminum rust free sign, with sealed outer surface over a microstructure that reflects light.
  - 2. 6"x12", M.U.T.C.D. R2-8P, aluminum rust free sign, with sealed outer surface over a microstructure that reflects light.
- B. Stop sign
  - 1. Sign shall meet the requirements of the Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction.
  - 2. 10'x2"x2" galvanized steel sign post.
  - 3. Commercial grade fast setting concrete bag mix that meets or exceeds the compressive strength requirements of ASTM C387, with 2"-3" slump.
- C. All other traffic signs (see plans for sign text)
  - 1. 18"x12", aluminum rust free sign, with sealed outer surface over a microstructure that reflects light.
  - 2. 10'x2"x2" galvanized steel sign post.
  - 3. Commercial grade fast setting concrete bag mix that meets or exceeds the compressive strength requirements of ASTM C387, with 2"-3" slump.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Stop Signs
  - 1. Mount metal signs to galvanized steel post.
  - 2. Excavate hole for concrete footings in locations shown on construction drawings.
  - 3. Set steel post in 12"x48" concrete footing so steel post is plumb and bottom of 18"x12" sign is 5' above finished grade.
- B. ADA Parking Signs
  - 1. Installation shall match existing ADA signs.

**END OF SECTION**

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## SECTION 32 91 19 – LANDSCAPE FINISH GRADING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications Sections apply to work of this Section.

#### 1.2 WORK INCLUDED

- A. Place topsoil in all general landscape areas.
- B. Finish grade topsoil for finish landscaping.
- C. Provide additional topsoil if required from an off-site source.

### PART 2 PRODUCTS

#### 2.1 MATERIAL

- A. Salvaged Topsoil: on site excavated material, graded, free of roots, rocks larger than 1/2", debris and large weeds.
- B. Additional Topsoil: When required, provided, placed and compacted by CONTRACTOR off site material free of debris, roots, and rocks larger than 1/2" in size.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify salvaged topsoil is acceptable for use.
- B. Verify trench backfilling and compacting has been completed and inspected.
- C. Verify subsoil base has been contoured, shaped and compacted to design grades.

#### 3.2 SUBSOIL PREPARATION

- A. Shape subsoil to remove uneven areas and low spots.
- B. Remove debris, roots, branches, and stones in excess of 1" in size. Remove subsoil contaminated with petroleum products if encountered.
- C. Scarify subgrade material to depth of 3" where topsoil is scheduled to be placed where equipment is used for hauling and spreading topsoil and has compacted subsoil.

#### 3.3 PLACING TOPSOIL

- A. Place topsoil in areas where seeding and/or sodding is required to a thickness of 6" lightly compacted depth.
- B. Place topsoil in relatively dry state, during dry weather.
- C. Finish grade topsoil eliminating rough or low areas while maintaining profiles and contour of subgrade and achieving required 6" compacted depth.
- D. Remove roots, debris, rocks larger than 1/2" in size, weeds, and foreign material while spreading.

## **SECTION 32 91 19 – LANDSCAPE FINISH GRADING**

- E. Manually spread topsoil close to trees, fences, buildings and other objects to prevent damage.
- F. Lightly compact topsoil after placement.
- G. Leave stockpile area and site clean and ready for seeding, sodding or other finish treatment.

### **3.4 TOLERANCES**

- A. Top of Topsoil: Plus or minus ½”.

### **3.5 PROTECTION**

- A. Protect landscaping and other site features remaining as part of completed project.
- B. Protect fences, sidewalks, utilities, structures and pavement from damage.

**END OF SECTION**

## SECTION 32 92 00 – TURF AND GRASSES

### PART 1 GENERAL

#### 1.1 WORK INCLUDED

- A. Fertilizing
- B. Seeding
- C. Sodding
- D. Mulching
- E. Maintenance

#### 1.2 REFERENCES

- A. FS O-F-241 - Fertilizers, Mixed, Commercial.

#### 1.3 DEFINITIONS

- A. Weeds: Includes Dandelion, Jimsonweed, Quack grass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

#### 1.4 REGULATORY REQUIREMENTS

- A. Comply with local governing regulatory agencies for fertilizer and herbicide composition.

#### 1.5 QUALITY ASSURANCE

- A. Provide to project A/E tags from seed mixture containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging prior to the start of seeding.
- B. Provide to project Architect certification for grass species in sod and location of sod source. The sod producer shall be a company specializing in sod production and harvesting with minimum of five years experience, and certified by the State of Wisconsin.

#### 1.6 TESTS

- A. Testing is not required if recent tests are available for imported topsoil. Submit these test results to testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

#### 1.7 MAINTENANCE DATA

- A. Submit maintenance data for the OWNER'S continuation of maintenance.
- B. Include maintenance instructions for the OWNER relating to cutting method and maximum grass height, type, application frequency, and recommended coverage of fertilizer to be utilized.

#### 1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed provided in damaged packages will not be accepted.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- C. Harvest, deliver, store, and handle sod in accordance with requirements of Turfgrass Producers International (TPI) (formally American Sod Producers Association) Specifications for Turfgrass Sod Materials and Transplanting / Installing.
- D. Schedule deliveries to coincide with topsoil operations and laying. Keep storage at job site to minimum without causing delays.
- E. Deliver, unload, and store sod on pallets within 24 hours of being lifted. Do not deliver small, irregular, or broken pieces of sod.

**SECTION 32 92 00 – TURF AND GRASSES**

1.9 MAINTENANCE SERVICE

- A. Maintain seeded areas until acceptable growth is established.
- B. Maintenance
  - 1. Mow grass at regular intervals to maintain a minimum height of 2-1/2". Do not cut more than one-third (1/3) of grass blade at any one mowing.
  - 2. Neatly trim edges and hand clip where necessary.
  - 3. Immediately remove any clippings after mowing and trimming.
  - 4. Water to prevent grass and soil from drying out.
  - 5. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
  - 6. Immediately re-seed areas which show bare spots.
  - 7. Protect seeded areas with warning signs during maintenance period.
- C. Acceptable Growth
  - 1. When the majority of the seeding reaches the height of one-third greater than the anticipated cutting height, mowing should then follow standard frequency. (e.g. If a Kentucky Bluegrass turf is to be maintained at a 3 inch cutting height the new seedlings should be mowed when they reach a height of 4 inches.) After the second mowing and after the assessment that no washouts or large bare areas exist, the growth shall be deemed acceptable and from that point on, it is the OWNER'S responsibility.

**PART 2 PRODUCTS**

2.1 ACCEPTABLE SEED SUPPLIERS

- A. L.L. Olds Seed Company
- B. Reinders
- C. The Scott's Company
- D. Horst Distributing
- E. Wisconsin Turf  
1917 W. Court Street  
P.O. Box 708  
Janesville, WI 53547-0708

2.2 TURF SEED MIXTURE

- A. General Turf Seed Mixture:
  - 50% Kentucky Bluegrass
  - 15% Creeping Red Fescue
  - 12% Chewing Fescue
  - 23% Improved Turf Type Perennial Ryegrassor Approved by CIVIL ENGINEER  
Seeding Rate of 6 lb. per 1,000 square feet

2.3 NATIVE SEED MIX

- A. WisDOT Seed Mix No. 75
- B. Application



## SECTION 32 92 00 – TURF AND GRASSES

1. Seed rate shall be per WisDOT 630.3.5
2. If seeding bare soil, include a Seeding Nurse Crop per WisDOT 630.2.1.5.3

### 2.4 LOW MOW SEED MIXTURE

- A. Seed Mixture: Low mow seed mixture shall be 'No-Mow' lawn mix as supplied by Prairie Nursery, Inc., P.O. Box 306, Westfield, WI, 53964. 1-800-476-9453
- B. Application
  1. Seed rate of 5-6 lbs. per 1,000 square feet.

### 2.5 SOD (If noted)

- A. Superior sod grown from certified, high quality, seed of known origin or from plantings of certified grass seedlings or stolons.
- B. Assure satisfactory genetic identity and purity.
- C. Assure over-all high quality and freedom from noxious weeds or an excessive amount of other crop and weedy plants at time of harvest.
- D. Sod shall be composed of three varieties minimum of 40% Kentucky Bluegrass (three varieties), 30% Perennial Ryegrass, and 30% Creeping Red Fescue.

### 2.6 SOIL MATERIALS

- A. Additional Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value: 5.4 minimum and 7.0 maximum.
- B. Salvaged Topsoil: Excavated from site and in accordance with Section 312000 - Earthmoving.

### 2.7 ACCESSORIES

- A. Mulching Material: Marsh hay or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
- B. Fertilizer: Starter Fertilizer to the following proportions: Nitrogen 10 percent, phosphoric acid 18 percent, soluble potash 22 percent. Apply at rate of .5 LBN per 1000 S.F.
- C. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of grass.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Verify that prepared soil base is ready to receive work of this section.
- B. Beginning of installation means acceptance of existing site conditions.
- C. Do not commence work of this Section until work of Sections 32 9113 and 32 9300 has been completed and approved.
- D. Final grade of soil after sodding of lawn areas is complete shall be one inch (25 mm) below top of adjacent pavement of any kind.
- E. Lay sod during growing season and within 48 hours of being lifted.
- F. Lay sod while top 6 inches (150 mm) of soil is damp, but not muddy. Sodding during freezing temperatures or over frozen soil is not acceptable.
- G. Lay sod in rows perpendicular to slope with joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with a sharp knife.
- H. Lay sod flush with adjoining existing sodded surfaces.
- I. Do not sod slopes steeper than 3:1. Consult with Architect for alternate treatment.

## SECTION 32 92 00 – TURF AND GRASSES

- J. After laying of sod is complete, roll horizontal surface areas in two directions perpendicular to each other.
  - K. Repair and re-roll areas with depressions, lumps, or other irregularities. Heavy rolling to correct irregularities in grade will not be permitted.
  - L. Water sodded areas immediately after laying sod to obtain moisture penetration through sod into top 6 inches (150 mm) of topsoil.
- 3.2 SEEDING
- A. Apply seed at a rate of 5-6 lbs. per 1,000 sq. ft. evenly in two (2) intersecting directions. Rake in lightly. Do not seed area in excess of that which can be mulched on same day.
  - B. Planting Season: Starting May 1 through October 1.
  - C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
  - D. Drag seeded area with lightweight drag to cover seed and level soil.
  - E. Immediately following seeding, fertilizing and compacting, apply mulch to a thickness of 1" to 1/2". Maintain clear of shrubs and trees. Crimping of mulch shall be performed in two (2) directions after placement of mulch.
  - F. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4" of soil.
- 3.3 FERTILIZING
- A. Apply fertilizer in accordance with manufacturer's instructions.
  - B. Apply after smooth raking of topsoil and prior to roller compaction.
  - C. Do not apply fertilizer at same time or with same machine as will be used to apply seed. Apply fertilizer after seed has been dragged and soil leveled.
  - D. Mix thoroughly into upper 2" of topsoil.
  - E. Lightly water to aid dissipation of fertilizer.
- 3.4 MAINTENANCE
- A. During the maintenance period, CONTRACTOR shall sprinkle to supplement rainfall to provide 1" minimum water per week, mow, control weeds (by mowing), repair poorly growing and/or eroded areas, etc.
  - B. Mowing shall be done regularly to maintain the lawn at a height of 2-1/2" to 3" at all times. In no case shall more than 25% of the total height of grass be removed in one cutting. Clippings shall be permitted to remain unless they are of such quality so that, in the opinion of the LANDSCAPE ARCHITECT, they might damage the lawn. In such cases, CONTRACTOR shall promptly remove the clippings and dispose of same off the site.

**END OF SECTION**

## SECTION 32 93 00 – PLANTS

### PART 1 GENERAL

#### 1.1 SCOPE OF WORK

- A. This work shall consist of furnishing and planting plants of the species, varieties and sizes specified, complete in place at the locations designated on the plans or as directed by the A/E. It shall include furnishing all necessary materials and performing all necessary work such as excavating plant holes, salvaging topsoil, potting, transplanting, backfilling, pruning, mulching, watering, heeling in, fertilizing, wrapping, guying and bracing, rodent protection and anti-desiccant, disposing of surplus and waste materials, necessary care and replacement.

#### 1.2 QUALITY ASSURANCE

- A. Perform work with personnel experienced in the work required in this section under direction of a skilled foreman. The Contractor shall have a minimum of five successful installations of similar projects and materials, or approval by ARCHITECT.

#### 1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Samples: Submit sample of stone mulch for landscape beds and mowing strip for approval by OWNER prior to installation.
- C. Maintenance Data: Include cutting and trimming method .
- D. Provide Owner with detailed written long term landscape maintenance information.
- E. Submit list of plant life sources.

#### 1.4 DELIVERY STORAGE AND HANDLING

##### A. General

- 1. All plant stock shall be dug and handled with care and skill to prevent injuries to the trunk, branches, and roots and shall be packed in an approved manner to insure arrival at the project site in good condition.
- 2. The plant stock shall be transported in enclosed vehicles or, in lieu of the enclosed vehicles, the plant tops shall be suitably protected from drying.
- 3. All plants furnished with earth balls or in containers shall be handled by the ball or container.

##### B. Bare Root Stock (BR)

- 1. Plant stock to be furnished BR shall be moved with the roots protected against drying out by the use of moist sphagnum moss, straw or other suitable material, and covered with canvas or other suitable covering in an approved manner.

##### C. Bare Root Potted Stock (BRP)

- 1. Plant stock to be furnished BRP shall be bare root plants potted in accordance with the following requirements and the planting details shown on the plans. The potting shall be the responsibility of the CONTRACTOR and shall be done by placing the plant in a plantable fiber container of the specified size and then placing and compacting the potting mixture backfill so that the elevation of the plant root collar and the backfill material is approximately 1" below the top of the container.
- 2. The potting shall include pruning of the plants before or at the time of potting and working the plant around as the potting mixture is added to insure that the roots are naturally spread or spaced within the pot. Fertilizer conforming to 2.01 G, H shall be placed on the soil in the pot after potting in accordance with the requirements of such subsection.
- 3. The plants shall be potted prior to May 1 of the year they are to be planted and shall be stored, watered and otherwise cared for by the CONTRACTOR in a suitable location off the highway right-of-way for at least four (4) weeks. The CONTRACTOR shall inform the

## SECTION 32 93 00 – PLANTS

A/E of the location of the potting and storage area at least ten (10) days before potting begins.

4. Only live, healthy, vigorously growing BRP plants will be acceptable for planting at the designated locations on the project site.

### D. Balled and Burlapped Stock (B&B)

1. Plant stock to be furnished B&B shall be moved with a compact dug ball of earth so firmly wrapped in burlap that upon delivery the soil in the ball is still firm and compact about the small feeding roots. Each ball shall be of sufficient size to encompass all the fibrous feeding roots necessary to insure successful recovery and development of the plant. The minimum sizes of balls, ball depth and diameters, and increased ball sizes for collected stock shall be in accordance with Recommended Balling and Burlapping Specifications, as set forth in the current edition of the American Standard for Nursery Stock sponsored by the American Association of Nurserymen, Inc.

### E. Balled and Potted Stock (B&P)

1. Plant stock to be furnished B&P shall be plants which have been dug from the growing site with the roots contained in a compact unbroken ball of earth and placed in a plantable fiber container. The size and shape of the earth ball shall conform to the approximate size and shape of the container so that the plant root collar is approximately 1" below the top of the container. Any voids shall be filled at potting time with native soil. The minimum ball size shall be equivalent to the ball size for B&B stock shown in the current American Standard for Nursery Stock as required for the plant specified.

### F. Container Grown Stock (CG)

1. Plants furnished CG shall be well rooted and established in the containers in which they are growing. They shall have grown in the containers sufficiently long enough for the new fibrous roots to have developed so that the root soil mass will retain its shape when removed from the container. The plants shall not have grown in the container long enough to become container bound. The container shall be sufficiently rigid to retain its shape and protect the plant root system during shipping and handling. Container size shall be in accordance with specifications for CG stock as stated in the current edition of the American Standard for Nursery Stock. Keep plants moist at all times and in the trays or containers till planting.

### G. Machine Transplanted Stock (MT)

1. Plants to be furnished or transplanted as MT stock shall be plants that are to be moved from the growing site to selected sites within the right-of-way by use of a tree transplanting machine. The machine shall be capable of digging and removing from the ground, an unbroken mass of earth of the specified size and shape. It shall be capable of lifting and transporting the mass of earth supporting the specified size plant and containing its roots in an undisturbed condition. The machine shall be capable of holding the soil mass and roots in the undisturbed condition until the tree is lowered into the growing position and the soil mass supported by the walls of the planting hole.

### H. Stone Mulch

1. Store products (until ready for installation) to prevent excessive mud, concrete or any other materials from coming into contact and affixing to the stone mulch.

## 1.5 PLANT ESTABLISHMENT PERIOD

### A. General

1. A plant establishment period of two (2) years shall follow the completion of planting.

### B. Two-Year Plant Establishment Period

1. The plant establishment period shall extend until August 1 of the second full growing season.

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### C. Care

1. The CONTRACTOR shall properly care for all plants from the time of planting until the partial or final acceptance of the work under the contract.
2. Proper care of plants shall consist of doing such watering, weeding, cultivating, pruning, spraying, tightening of braces and guys, retying, wrapping, re-mulching and other work as may be necessary to keep the plants in a neat appearance and in a healthy growing condition. In addition to the watering required in 3.01, a, entitled MAINTENANCE, complete watering shall be performed at 12 to 15 day intervals between project start and September 15, if required. Such intervals may be lengthened when weather conditions and soil moisture permit. Additional watering may be ordered by the OWNER, CONSTRUCTION MANAGER, or A/E at any time during the plant establishment period should conditions require such watering.
3. A sufficient amount of water shall be placed in each plant hole at the time of each watering to keep the topsoil backfill material in a moist condition, and to keep the plant in a healthy growing condition.
4. All evergreens that die during the course of the plan establishment period shall be removed and disposed of by the CONTRACTOR as their dead conditions become evident.
5. All mulched areas shall be kept free of all vegetation, except the specified plants, by hoeing, hand weeding or by the use of herbicides if approved by the A/E.
6. All vines shall be strung to fences and runners shall be directed toward retaining walls or structures, as the case may be, during plant establishment period.
7. Pesticides shall be applied as required to control insects and disease and to keep the plants in a healthy condition.
8. All plants that die or show evidence of dying during the plant establishment period shall be replaced at the CONTRACTOR'S expense at the earliest appropriate planting time after this condition becomes apparent. Replacement will be permitted until June 1 of the year in which the final inspection is made.
9. All bracing and guying materials shall be removed and disposed of by the CONTRACTOR after the final inspection of the plantings.

### D. Acceptance and Replacement of Plant Material

1. Near the end of the applicable plant establishment period, but no later than September 15, the inspection of the planting will be made and only those plants that are in a healthy growing condition and which meet the following minimum requirements will be accepted and measured for payment at the contract lump sum price. Plant sizes and standards shall be in accordance with the AMERICAN STANDARDS FOR NURSERY STOCK.
2. Evergreens shall exceed the minimum size of the specified size range and all coniferous types shall have fully developed, mature needles and average sized buds on current season's growth.
3. Deciduous shrubs shall exceed the requirements of the specified size range and have mature, average sized leaves typically distributed throughout the branch system.
4. Deciduous vines shall have the required number of runners, each exceeding the minimum required length.
5. The plants not meeting the foregoing requirements shall either be removed or replaced with satisfactory plants during the current fall planting season, or at the option of the A/E, be allowed to remain in place. Materials and method of replacement planting shall be the same as specified for the original planting, except that plants furnished BRP may be replaced with B&P or CG stock. Such plants when satisfactorily replaced or allowed to

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remain will be measured and paid for at the reduced contract unit price provided in a lump sum Basis of Payment.

### 1.6 WARRANTY

- A. Provide to a period through the second spring of growth, a 2yr. warranty from date of Substantial Completion for the Project.
- B. Replace plant materials found dead, or not in a healthy growing condition.
- C. Replacements
  - 1. Plant materials of same size and species, with a new warranty commencing on the date of replacement.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Trees and Plants
  - 1. Species and size identified in the plant schedule, grown in climatic conditions similar to those in the locality of the work.
- B. Compost
  - 1. Compost shall be a standard commercial compost of cattle, sheep or poultry manure, or other organic material acceptable to the A/E.
- C. Peat Moss
  - 1. Peat Moss shall consist of at least 75% of partially decomposed stems and leaves of sphagnum, hypnum, polytrichum and other mosses in which the fibrous and cellular structure is still recognizable. It shall be nearly free of decomposed colloidal residue, wood, and other foreign matter, and shall be brown to black in color. Humus peat will not be acceptable. Peat moss shall have the following characteristics:
    - a. Moisture content shall not exceed 60% by weight.
    - b. Ash content shall not exceed 20%, based on the oven dry weight of the material.
    - c. The pH value shall be not less than 3.2 nor greater than 7.0 at 25 degrees C.
    - d. Water holding capacity shall be not less than 400% by weight, on an oven dry basis.
    - e. Upon request, the CONTRACTOR shall furnish the A/E with a representative sample of the peat moss for testing in accordance with the Federal Specification for Peat, Moss; Peat, Humus; and Peat, Reed Sedge numbered Q-P-166c.
    - f. The CONTRACTOR shall furnish the A/E with a certificate stating the type of peat moss, the brand name, and the country or place of origin. If packed in bales and if bale size is used in determining quantities for mixing, the certificate shall also contain the cubic feet of compressed bale size, the compression ratio, and the approximate weight of the bales. A certificate will not be required if this information is marked on the bales.
- D. Topsoil
  - 1. Topsoil shall be salvaged from the plant hole excavation whenever such topsoil conforms to the above requirements. The sod from the plant hole excavation may be used for backfill, together with topsoil, providing it is thoroughly broken into small pieces and used in limited quantities near the bottom of the plant hole and in such manner that it will not be in contact with the small feeder roots.
- E. Potting Mixture

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1. Potting mixture shall consist of a mixture of peat moss, topsoil, and sand in a ration of 1:1:1 by volume. Fertilizer shall be thoroughly incorporated in the mixture at the rate of four (4) pounds of fertilizer to each cubic yard of mixture.
2. The peat moss shall conform to the requirements of Subsection C and topsoil to Subsection D. The sand shall be approved by the A/E and 100% shall pass a 3/8" sieve.

### F. Fertilizer

1. Fertilizer shall conform to the pertinent requirements of the following:

- a. Fertilizer for Potting Mixtures

Unless otherwise specified, the fertilizer to be mixed with the potting soil shall be a super phosphate meeting the following minimum requirements:

Nitrogen	0%
Phosphoric Acid	20%
Potash	0%

- b. Fertilizer for BRP Stock

Fertilizer to be placed on the soil in containers shall be of the controlled release type and shall have the following minimum requirements:

Nitrogen, not less than	18%
Phosphoric Acid, not less than	9%
Potash, not less than	9%

The fertilizer shall consist of granules of soluble nutrients, each granule of which shall be enclosed in a water permeable resinous film.

The fertilizer shall be spread evenly over the top of the container at the rate of 2 oz. per cubic foot of container volume.

- c. Fertilizer for Plant Holes

Fertilizer to be used in plant holes shall be a water soluble fertilizer contained in a micro pore slow release polyethylene packet. The amount of fertilizer in each packet shall be minimum of one ounce.

The fertilizer shall meet the following minimum requirements:

Nitrogen, not less than	16%
Phosphoric Acid, not less than	8%
Potash, not less than	16%

- d. Fertilizer for Wood Chip Mulch

Fertilizer to be used on areas to be mulched with wood chips shall be a slow release ureaform fertilizer having at least 38% nitrogen.

### G. Water

1. Water used shall be free from any impurities or substances which might injure the plant.

### H. Hardwood BarkMulch

1. Wood chips shall be chips such as are obtained from any standard wood or brush chipping machine and shall be substantially free of noxious weed seeds or other objectionable foreign materials. The mulch used shall meet the approval of the A/E.

### I. Wrapping

1. Wrapping, when specified shall consist of a two-ply waterproofed crepe tree wrapping paper, laminated with a layer of pliable asphalt material.

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- J. Wound Dressing
1. Wound dressing, when required, shall consist of an asphalt base tree paint or other acceptable material suitable for application by brushing or spraying on bruised or cut surfaces of plants.
- K. Rodent Protection
1. Rodent protection, when specified, shall consist of galvanized hardware cloth, extruded aluminum mesh, or a durable preformed plastic material. The hardware cloth or aluminum mesh, if used, shall have at least three meshes per linear inch and shall be used in conjunction with a steel rod having a minimum size of 3/8" x 48". The plastic material shall be a durable, resilient, preformed plastic spiral acceptable to the A/E. Such material shall have a natural, earth-tone color.
- L. Bracing and Guying Materials
1. When specified, these materials shall consist of such wood or steel stakes, wire, rubber hose, soft rope or straps, turnbuckles, and other material as needed to perform the work. Stakes shall be of solid durable wood, approximately 2 x 2" and of the required length, except that stakes used for bracing may be approved steel posts of the required length.
  2. Wire of good quality shall be No. 11 or 12 steel wire and when used for trees of four (4) inches or less in diameter. No. 9 or 10 for trees over four inches in diameter. A suitable turnbuckle for adjusting the wire tension shall be used with the larger wire.
- M. Anti-Desiccant
1. Anti-desiccant, when specified, shall be an approved emulsion which will provide a film over plant surfaces permeable enough to permit transpiration.
- N. Equipment
1. The CONTRACTOR shall furnish and have available, sufficient watering equipment, including tanks, pumps, hoses, and incidentals to fully perform all of the watering required in Subsection 301, A. The capacity and adequacy of such equipment shall be determined on the basis of supplying approximately 20 gallons of water per large tree, ten gallons per small tree, five gallons per shrub and two and one-half gallons per vine or sumac plant for each of the required watering. A source of water capable of supplying the above amounts shall be available.
- O. Stone Mulch
1. Stone for landscape and beds to be naturally rounded and washed, graduation from 1" to 1-1/2" maximum, River Stone or Mississippi Pebble
  2. Color to be selected by owner.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Planting
1. All planting of BR, B&B, BRP, B&P, CG, and MT plants, unless otherwise directed, shall be performed in accordance with the method herein provided. Insofar as practicable, BR plants shall be protected against drying by keeping the roots covered with a canvas or other suitable covering until planted.
  2. The soil in the bottom of the hole which has been excavated to the prescribed requirements shall be loosened to a depth of three inches and mixed with an equal amount of topsoil. A mound of soil shall be formed in the center of the hole to support the roots or ball of the plant. The plant shall be placed on the mound of soil and held in a vertical position. The roots of BR plants, pruned as required, shall be spread out to their approximate natural position. B&B plants shall be placed in their wrapped ball, and shall be moved and handled only by the ball. The plant shall be so set, by adjusting the



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elevation of the mound that after settlement the plant will stand approximately the same depth it stood in the nursery or field.

3. Unless otherwise specified, the plant hole shall be backfilled with topsoil to which compost has been added at the ratio of six (6) parts soil to 1 (1) part compost by volume. The soil compost mixture shall be placed in layers around the roots or ball. Each layer shall be carefully tamped in place in a manner to avoid injury to the roots or ball disturbing the position of the plant. When approximately 2/3rds of the plant hole has been backfilled, the hole shall be filled with water and the soil allowed to settle around the roots. B&B plants shall have the burlap cut away or folded back from the top of the ball before applying the water. After the water has been absorbed, the plant hole shall be filled with topsoil and tamped lightly to grade. Any settlement shall be brought to grade with topsoil. Unless otherwise directed or specified, a shallow rain cup or rain basis shall be formed in the completed backfill by shaping the soil around the plant.
4. The holes made for MT plants shall be filled to about ½ the hole depth with a slurry made from a 1:1 mixture of water and compost by volume. The slurry shall be placed in the hole just prior to placing the tree in the hole. Any voids remaining when the machine is removed shall be backfilled with topsoil.
5. After the plantings have been in place at least two (2) days, but not more than five (5), an inspection of such plantings shall be made. Plant depths and plumbness shall be adjusted as necessary and any additional required backfill shall be placed. All plants being inspected shall be thoroughly watered during the inspection period.

### B. Fertilizing

1. Fertilizer for Potting Mixtures
  - a. Fertilizers for potting mixtures shall be incorporated in the mixtures at the rate of four (4) pounds of fertilizer per cubic yard of mixture so that the fertilizer is uniformly distributed.
2. Fertilizer for Plant Holes
  - a. The number of packets specified on the plans to be placed in each plant hole shall be uniformly spaced around the outside of the plant hole during the backfill operation. The packets shall be placed as shown on the planting detail sheet after the backfilling is partially completed. They shall be at least six (6) inches below the final grade of the backfill material
  - b. If specified for MT plants, the packets shall be equally spaced around the hole by placing in niches dug into the plant hole wall from 9" to 18" below the soil surface.

### C. Mulching

1. Mulch, when specified, shall be placed over the backfilled plant hole or plant bed within the specified area to a depth of approximately three (3) inches after any necessary backfilling, adjustment, and watering has been performed, unless otherwise specified.

### D. Wrapping

1. When specified to be wrapped, the trunks of trees shall be wrapped with wrapping material overlapping one and one-half (1 ½) inches, wound from the ground line to the lowest main branches. The wrapping shall be securely tied in at least three places, including the top, middle and bottom. The wrapping shall be done as soon as practical after planting.

### E. Rodent Protection

1. When required, a rodent protective material shall be applied to the plants. This is appropriate on Birch species.

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### F. Bracing

1. When specified, trees shall be braced with a stake driven into the ground near the base of the tree to a depth of two (2) to three (3) feet, or until sufficiently solid to support the tree, and shall extend upward to about six (6) inches below the lowest main branches. The tree shall be fastened to the stake by a means of a soft rope, strap, or a wire enclosed in a hose in such a manner as to avoid injury to the tree.

### G. Guying

1. When specified, trees shall be guyed with three (3) wires whose upper ends encircle the tree trunk, just above the lowest main branches of deciduous trees and at a point above the ground line of 2/3rds the height of evergreen trees. The lower ends shall be anchored to stakes set in the ground around the tree, equal distance apart and at a distance from the tree of approximately 3/4ths the distance from the ground to the upper point of fastening. The anchor stakes shall be notched to prevent slipping of the wire and shall be driven into the ground at a slight angle away from the tree to a depth of 18" or more until solid, and shall extend for three (3) inches above the ground.
2. Each wire where it encircles the tree shall be enclosed in a hose of sufficient length to clear the trunk six (6) inches at the ends. The wires shall be drawn taut to equal tension by means of twisting or use of turnbuckles, and securely fastened, with the trunk of the tree remaining in a vertical position.

### H. Disposal of Excess and Waste Material

1. All excess excavation, waste materials, or other debris shall be removed and disposed of by the CONTRACTOR.

## 3.2 INSTALLATION

### A. General

1. The normal spring planting season for all plants except those handled BRP shall extend to June 1. Unless otherwise approved, BRP plants shall not be planted at the designated locations on the project site after June 1<sup>st</sup> to August 15<sup>th</sup>. The normal fall planting season for all plants, except evergreens, shall begin on October 1<sup>st</sup>. Fall evergreen planting shall be done between September 1 and October 1. Unless otherwise approved, planting shall not be done when the ground is frozen or when the soil is in an unsatisfactory condition for planting. Planting shall not be done when the temperature is below freezing unless plant roots are satisfactorily protected to prevent damage.

### B. Delivery and Temporary Storage

1. At least three (3) days prior to each delivery of plant material to the potting, storing, or project site, the CONTRACTOR shall notify the A/E of such contemplated delivery.
2. In so far as practicable, plant stock shall be planted on the day of delivery at the project site. In the event this is not possible, the plant stock shall be temporarily stored by "heeling-in" or by placing in a well ventilated, cool, moist storage place and shall be adequately protected against drying by the use of moist sphagnum moss, straw, or other suitable covering around the roots of BR stock and the balls of B&B stock.
3. Plants growing in pots or containers shall be spaced to provide for air circulation and reasonably unrestricted top spread. Potted and container grown plants shall be cared for and watered as necessary to keep them in a healthy growing condition while in storage.
4. Bare root plants, when "heeled-in", shall be placed in a spade depth trench, have their roots fully covered with damp topsoil and be protected from the sun and wind. When "heeled-in" all plants shall be properly cared for by the CONTRACTOR. Plants shall not remain "heeled-in" from one planting season until the next.

### C. Excavation of Plant Holes

1. The plant holes shall be centered at the location stake, unless otherwise permitted by the A/E.

## SECTION 32 93 00 – PLANTS

2. The plant holes, except for MT stock, shall be excavated to the minimum dimensions shown on the plans or established by the A/E, provided, however, that the plant hole shall be large enough to permit placing at least six (6) inches of backfill material around and at least two (2) inches beneath the root system of BR stock and the pots, balls or containers of BRP, B&B, B&P and CG stock. When a minimum size hole is excavated, the hole shall be excavated cylindrical in shape with vertical sides and a flat or saucer-shaped bottom.
3. Unless soil conditions make it impractical, planting holes for MT plants shall be dug by the tree moving machine and shall be approximately the same size and shape as the soil mass containing the root system of the machine moved plant.
4. The sod and topsoil suitable for backfilling shall be kept separate from the excavated subsoil.
5. When planting on a slope, the minimum depth of the plant hole shall be measured from the downward side of the slope at the hole.
6. In the event it is necessary to suspend planting operations until the following planting season, any open plant holes shall be backfilled before suspending the work.

### D. Pruning

1. The bruised or broken parts of large or fleshy roots shall be cut off smoothly before planting or potting. The tops of deciduous plants shall be pruned either before or at the time of planting or potting. Unless otherwise specified or directed by the A/E, for deciduous BR stock this shall consist of removing 1/3 to 1/2 of the top by thinning out and heading back the stems and top branches; and for deciduous B&B, B&P and CG stock, this shall consist of removing dead and broken branches and thinning and heading back the stems and branches to compensate for root loss and to shape the plant. The pruning shall be done so that the plant retains its natural form. Except when heading back, all cuts shall be made outside of the branch bark ridge. Evergreen plants shall not be pruned except to remove dead or broken branches. All cut surfaces of one (1) inch or more in diameter shall be painted with a tree wound dressing.

### E. Anti-Desiccant

1. Anti-desiccant, when specified, shall be applied to evergreen plants prior to or at the time of planting and to BRP plants prior to shipment from the storage place. It shall be applied to plants to be transplanted prior to transplanting. The rate and method of application of the emulsion shall be according to the manufacturer's recommendations.

**END OF SECTION**

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**DIVISION 33**



## SECTION 33 31 00 – SANITARY SEWER SYSTEMS

### PART 1 GENERAL

#### 1.1 WORK INCLUDED

- A. Connection to existing Sanitary Sewer Service Lateral.
- B. Trenching and backfilling required for work of this section.
- C. Furnish and install piping for sanitary sewer service, appurtenances and bedding from public main to within 5 feet of building.

#### 1.2 REFERENCE

- A. Standard Specifications for Sewer and Water Construction in Wisconsin, 6th Edition, Public Works Industry Improvement Program, 2835 North Mayfair Road, Milwaukee, WI 53227.
- B. AWWA - American Water Works Association Standards.
- C. State of Wisconsin Administrative Code, Chapters SPS 382 and SPS 384.

### PART 2 PRODUCTS

#### 2.1 SANITARY SEWER PIPE

- A. Polyvinyl Chloride Pipe (PVC), SDR-35 PVC, meeting the requirements of ASTM D3034, and push-on joints with elastomeric gaskets meeting the requirements of ASTM D3212. Do not mix different manufacturer's products, or fittings.
- B. Polyvinyl Chloride Pipe (PVC), Schedule 40 Pressure Pipe PVC, meeting the requirements of ASTM D1785 or D2665. All joints must be glued. All fittings must be pressure rated. Do not mix different manufacturer's products, or fittings.
- C. Polyvinyl Chloride Pipe (PVC), Class 125 Pressure Pipe PVC, meeting the requirements of ASTM D1785 or D2665. All fittings must be pressure rated. Do not mix different manufacturer's products, or fittings.

#### 2.2 PVC SEWER PIPE BEDDING

- A. PVC sewer pipe bedding shall meet requirements of Table 34, Article 8.43.2 of Standard Specifications for Sewer and Water Construction.

#### 2.3 PIPE INSULATION

- A. Rigid closed-cell extruded polystyrene insulation suitable for buried insulation.
  - 1. Insulation shall have a minimum thickness of 2.5 inches.
  - 2. Insulation shall be installed as detailed in construction documents and in location shown on construction documents.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. PVC pipe installation shall meet requirements of Chapter 3.2.0 of Standard Specifications for Sewer and Water Construction.

#### 3.2 TRACER WIRE

- A. 18 gauge wire with 0.015 inch thick vinyl insulation, insulation color green.
- B. Moisture, oil and gasoline resistant.
- C. Splices either solder or brass clamp wrapped with electrical tape or shrink-wrapped.
- D. Exterior access locations shall include a means of protecting the tracer wire.
- E. Install warning wire along the length of all non-metallic pipes.
- F. Tracer wire shall be located directly above and within 6 inches of the non-metallic pipe.

## **SECTION 33 31 00 – SANITARY SEWER SYSTEMS**

### **3.3 SEPARATION FROM WATER MAIN**

- A. Sanitary sewer mains shall be placed at least 8 feet horizontally (center to center) from any existing or proposed water main. If, due to ledge rock conditions or physical barriers, the Project Manager determines that the 8-foot horizontal separation cannot be maintained, the horizontal separation may be reduced to a minimum of 3 feet if the bottom of the water main is at least 18 inches above the top of the sewer.
- B. When sanitary sewer mains cross under water mains, provide a minimum separation of 12 inches from the bottom of the water main to the top of the sewer. When sanitary sewer mains cross over water mains, provide a minimum of 18 inches from the bottom of the sewer to the top of the water main.

### **3.4 AS-BUILT PLAN**

- A. Contractor shall provide an “As-Built” plan with all measurements to the nearest 0.01 foot at no cost to the OWNER or ARCHITECT.

### **3.5 FIELD QUALITY CONTROL**

- A. Testing and Inspection:
  - 1. Test sanitary sewer in accordance with State of Wisconsin Administrative Codes Section SPS 382.21.
  - 2. Tracer Wire Conductivity:
    - a. After completion of non-metallic sewer construction, the Contractor shall furnish a locator and using a low voltage circuit, test the entire trace wire system in the presence of the Architect or Engineer.
    - b. The test shall consist of a continuous above ground trace of the non-metallic sewer system, areas failing the location test shall be corrected at no additional cost to the Owner.

**END OF SECTION**



## SECTION 33 41 00 – STORM UTILITY DRAINAGE PIPING

### PART 1 GENERAL

#### 1.1 WORK INCLUDED

- A. The CONTRACTOR shall provide all materials, labor, equipment and services necessary for the completion of the work specified in this section.
- B. Installation of storm sewer pipe and manhole structures.

#### 1.2 REFERENCES

- A. 6<sup>th</sup> Edition of Standard Specifications for Sewer and Water Construction in Wisconsin, Public Works Industry Improvement Program, 2835 North Mayfair Road, Milwaukee, WI 53223.
- B. Standard Specifications for Highway and Structure Construction, Current Edition, State of Wisconsin, Department of Transportation, Division of Highways.
- C. Wisconsin Department of Safety and Professional Services (SPS), Wisconsin Plumbing Products Register, latest edition.

### PART 2 PRODUCTS

#### 2.1 STORM SEWER PIPE AND CULVERT

- A. Storm sewer pipe with diameters greater than 10" may use any of the pipe materials below unless specifically identified on the plan.
- B. Polyvinyl Chloride (PVC) pipe conforming to ASTM D3034. Pipes over 15" in diameter shall meet the requirements of ASTM F679. Do not mix different manufacturer's products or fittings.
- C. Corrugated Wall High-density Polyethylene (HDPE) pipe with diameters 12"-36", shall meet the requirements of ASTM F2306, AASHTO M-294, Type S. Joints for fittings and pipe shall be soil-tight bell and spigot, provided with rubber gasket. Rubber gasket shall be installed by the pipe manufacturer.
- D. Perforated underdrain storm sewer pipe with diameters less than 10" may High-density Polyethylene (HDPE) pipe conforming to AASHTO M252, type CP. Underdrain shall be wrapped with a geotextile fabric of knitted, woven, or non-woven fibers of polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride. Do not use slit film woven fabrics. Fabric shall have a minimum grab tensile strength of 35 lb (ASTM D-46320), an apparent opening size No. 30-200 (ASTM D-4751), and a minimum permittivity of 1.35 s<sup>-1</sup>.

#### 2.2 PIPE BEDDING

- A. Pipe bedding shall conform to Section 312000 Earthmoving, 2.1.D Stone Bedding.
- B. Use bedding material of 3/8" crushed stone chips with the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
1/2-inch	100%
3/8-inch	90-100%
No. 8	0-15%
No. 30	0-3%

#### 2.3 CONNECTIONS

- A. Connections between pipes shall be made by using fittings furnished by the manufacturer of the pipe and designed specifically for that purpose.

#### 2.4 PIPE INSULATION

- A. Rigid closed-cell extruded polystyrene insulation suitable for buried insulation.
- B. Insulation shall have a minimum thickness and width as detailed in construction documents.
- C. Insulation shall be installed as detailed in construction documents and in location shown on construction documents.

## SECTION 33 41 00 – STORM UTILITY DRAINAGE PIPING

### 2.5 CONCRETE MANHOLE CASTINGS AND GRATES

- A. Neenah Foundry Casting and Grates or approved equivalent shall be provided as specified in the construction documents for all concrete catch basins, manholes, and inlet structures.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Install storm sewer pipe in accordance with the Standard Specifications for Highway and Structure Construction, 2003 Edition subsection 607.3 and supplemented as follows:
- B. Trench width shall be in accordance with ASTM Designation D2321 for the standard practice for Underground Installation of Flexible Thermoplastic Sewer Pipe. Minimum width of trench shall be not less than the greater of either the pipe outside diameter plus 16 inches or the pipe outside diameter times 1.25 plus 12 inches.
- C. Joints for storm sewer pipe shall be sealed to 10 psi.
- D. Install perforated under drain in accordance with Section 612 of the Standard Specifications for Highway and Structure Construction.

#### 3.2 STORM SEWER OUTFALL

- A. Construct storm sewer outfall in accordance with Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction, 2003 Edition.

#### 3.3 CLEANING CULVERTS AND STORM PIPES

- A. CONTRACTOR shall remove all silt and debris accumulated in the culverts and storm sewer pipe, including pipe, inlets and outlets of the system. This work shall be performed after the completion of paving and after all turf areas have an established sufficient growth of grass to prevent sediment runoff.

#### 3.4 SEPARATION FROM WATER MAIN

- A. Storm sewer mains shall be placed at least 8 feet horizontally (center to center) from any existing or proposed water main. If, due to ledge rock conditions or physical barriers, the Project Manager determines that the 8-foot horizontal separation cannot be maintained, the horizontal separation may be reduced to a minimum of 3 feet if the bottom of the water main is at least 18 inches above the top of the sewer.
- B. When storm sewer mains cross under water mains, provide a minimum separation of 12 inches from the bottom of the water main to the top of the sewer. When storm sewer mains cross over water mains, provide a minimum of 18 inches from the bottom of the sewer to the top of the water main.
- C. If an existing water main is encountered while laying the storm sewer and it is impossible to obtain the proper vertical separation, immediately inform the ARCHITECT and reconstruct the water main for a minimum distance of 8 feet on either side of the storm sewer to permit centering one full length of water main over the storm sewer.

#### 3.5 TRACER WIRE

- A. 18 gauge wire with 0.015 inch thick vinyl insulation, insulation color green.
- B. Moisture, oil and gasoline resistant.
- C. Splices either solder or brass clamp wrapped with electrical tape or shrink-wrapped.
- D. Exterior access locations shall include a means of protecting the tracer wire.
- E. Install warning wire along the length of all non-metallic pipes.
- F. Tracer wire shall be located directly above and within 6 inches of the non-metallic pipe.

## **SECTION 33 41 00 – STORM UTILITY DRAINAGE PIPING**

### **3.6 AS BUILT PLAN**

- A. Contractor shall provide an “As Built” plan with all measurements to the nearest 0.01 foot at no cost to the OWNER or ARCHITECT.

### **3.7 FIELD QUALITY CONTROL**

- A. Testing and Inspection:
  - 1. Tracer Wire Conductivity:
    - a. After completion of non-metallic sewer construction, the Contractor shall furnish a locator and using a low voltage circuit, test the entire trace wire system in the presence of the OWNER.
    - b. The test shall consist of a continuous above ground trace of the non-metallic sewer system; areas failing the location test shall be corrected at no additional cost to the Owner.

**END OF SECTION**

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