

## PROJECT MANUAL - VOLUME 2

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Project No.: 14-025

# Renaissance Center Renovation

for

## Joliet Junior College

1215 Houbolt Road  
Joliet, Illinois 60431



DEMONICA KEMPER ARCHITECTS

125 N. Halsted Street, Suite 301  
Chicago, Illinois 60661  
Phone: 312.496.0000



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### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 21 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in the specification section.

#### 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make his portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

#### 1.3 COORDINATION DRAWINGS

##### A. Definitions:

- 1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
- 2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested

areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. KJWW will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by KJWW. KJWW will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1.) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2.) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3.) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4.) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5.) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:



1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

#### 1.4 QUALITY ASSURANCE

##### A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

##### B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

##### C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Joliet Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are

not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Examination of Drawings:

1. The drawings for the fire protection work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in fire protection documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.

- a. Any item listed as furnished shall also be installed, unless otherwise noted.
- b. Any item listed as installed shall also be furnished, unless otherwise noted.

F. Field Measurements:

- 1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

G. Electronic Media/Files:

- 1. Construction drawings for this project have been prepared utilizing Revit.
- 2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
- 3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
- 4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
- 5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
- 6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
- 7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
- 8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

1.5 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

- 1. Submittals list:

<b><u>Referenced Specification Section</u></b>	<b><u>Submittal Item</u></b>
21 13 00	Sprinkler Systems
21 13 00	Fire Protection Equipment

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
  - a. Date
  - b. Project title and number
  - c. Contractor's name and address
  - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - e. Description of items submitted and relevant specification number
  - f. Notations of deviations from the contract documents
  - g. Other pertinent data
  
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
  - a. Date
  - b. Project title and number
  - c. Architect/Engineer
  - d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses
  - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
  
3. Composition:
  - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
  
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
  
5. Contractor's Approval Stamp:
  - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.

- c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1.) Only approved manufacturers are used.
    - 2.) Addenda items have been incorporated.
    - 3.) Catalog numbers and options match those specified.
    - 4.) Performance data matches that specified.
    - 5.) Electrical characteristics and loads match those specified.
    - 6.) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7.) Dimensions and service clearances are suitable for the intended location.
    - 8.) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9.) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 21 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 21 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

1.6 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
  1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
  2. Submit in Excel format.
  3. Support values given with substantiating data.
- C. Preparation:
  1. Itemize the cost for each of the following:
    - a. Overhead and profit.
    - b. Bonds.
    - c. Insurance.
    - d. General Requirements: Itemize all requirements.

2. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
    - a. Contractor's own labor forces.
    - b. All subcontractors.
    - c. All major suppliers of products or equipment.
  3. Break down all costs into:
    - a. Material: Delivered cost of product with taxes paid.
    - b. Labor: Labor cost, excluding overhead and profit.
  4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
    - a. Each piece of equipment requiring shop drawings (e.g., fire pump, double interlock pre-action system, backflow preventer, etc.) using the project nomenclature (FP-1, DIPS-1, BFP-1, etc.).
    - b. Each sprinkler zone. In addition, break down the material and labor based on geography (building, floor, wing and/or phase).
    - c. Commissioning
    - d. Record drawings
    - e. Punchlist and closeout
- D. Update Schedule of Values when:
1. Indicated by Architect/Engineer.
  2. Change of subcontractor or supplier occurs.
  3. Change of product or equipment occurs.

#### 1.7 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

#### 1.8 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

#### 1.9 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the



installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

#### 1.10 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

#### 1.11 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

### PART 2 - PRODUCTS

NOT APPLICABLE

### PART 3 - EXECUTION

#### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employee and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or

other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days notice to the Architect/Engineer prior to:
  - 1. Covering exterior walls, interior partitions and chases.
  - 2. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
  - 1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. Pipe wall penetrations are sealed.
    - b. Pipe identification is installed.
    - c. Branch piping in the location of sprinklers shall be dropped to the ceiling.
  - 2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  - 3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  - 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
  - 3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  - 4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional

time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

- C. Before final payment is authorized, this Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including marked-up or reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
  4. Inspection report by the State Fire Marshal of the fire protection system.
  5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

### 3.4 OPERATION AND MAINTENANCE MANUALS

- A. General:
1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
  2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.
- B. Electronic Submittal Procedures:
1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
  2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
  3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
  4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    - a. O&M file name: O&M.div21.contractor.YYYYMMDD
    - b. Transmittal file name: O&Mtransmittal.div21.contractor.YYYYMMDD

5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

### 3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
  - 1. Explanation of all system flow diagrams.
  - 2. Maintenance of equipment.
- E. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
  - 1. Sprinkler System(s) - 4 hours.
- G. Operating Instructions:
  - 1. Contractor is responsible for all instructions to the Owner's representatives for the fire protection and control systems.
  - 2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.6 SYSTEM COMMISSIONING

- A. The fire protection systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- C. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.7 RECORD DOCUMENTS

- A. The following paragraph supplements Division 1 requirements:

Contractor shall maintain at the job site a separate and complete set of fire protection drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the fire protection systems.

- B. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of other control devices, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.

### 3.8 PAINTING

- A. This Contractor shall paint the following items:
  - 1. Exposed sprinkler piping.
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- D. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.
- F. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
  - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
  - 2. Color of paint shall be as follows:
    - a. Match surrounding architectural features.

### 3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### 3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

**END OF SECTION 21 05 00**

**READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION**

In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

- 1. Penetrations fire sealed and labeled in accordance with specifications.
- 2. Fire protection system operational.
- 3. Pipes labeled.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

\* \* \* \* \*



## SECTION 21 05 03 - THROUGH PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

#### 1.3 REFERENCES

- A. UL 723 - Surface Burning Characteristics of Building Materials
- B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- D. Warnock Hersey - Directory of Listed Products
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- G. NFPA 5000 – Building Construction Safety Code

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings:
  - a. Floor penetrations located outside wall cavities.
  - b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.6 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  1. 3M; Fire Protection Produces Division.
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk.
  4. Tremco; Sealant/Weatherproofing Division.
  5. Johns-Manville.
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems

### 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.

- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

- 1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated  
 F Rating = Floor/Wall Rating  
 T Rating = Floor

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

- 2. Non-Combustible Framed Walls - 1 or 2 Hour Rated  
 F Rating = Wall Rating  
 T Rating = 0

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

- 3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated  
 F Rating = Wall/Floor Rating  
 T Rating (Floors) = Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999

<u>Penetrating Item</u>	<u>UL System No.</u>
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

#### 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.

- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### 3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### 3.4 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

**END OF SECTION 21 05 03**



## SECTION 21 05 29 - FIRE SUPPRESSION SUPPORTS AND ANCHORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

#### 1.2 QUALITY ASSURANCE

- A. Support Sprinkler Piping in conformance with NFPA 13.

#### 1.3 REFERENCES

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- B. NFPA 13 - Standard for the Installation of Sprinkler Systems.

#### 1.4 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

### PART 2 - PRODUCTS

#### 2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Column #1
2" and smaller	3/8"
2-1/2" through 3-1/2"	1/2"
4" and 5"	5/8"

Column #1: Steel pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

#### 2.2 PIPE HANGERS AND SUPPORTS

- A. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58 and 127 (where applicable).
- B. Support and laterally brace vertical pipes at every floor level in multi-story structures, and more frequently when required by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings or lugs. Provide

sufficient flexibility to accommodate expansion and contraction without compromising fire barrier penetrations and other fixed takeoff locations.

Acceptable Products:

Anvil - Fig. CT121  
Cooper/B-Line - Fig. B3373CT  
Erico - Model 510  
Nibco/Tolco - Fig. 82

C. Unless otherwise indicated, hangers shall be as follows:

1. Clevis Type:

Service: Bare Metal Pipe

Acceptable Products: Bare Steel Pipe

Anvil Fig. 260  
Cooper/B-Line Fig. 3100  
Erico Model 400  
Nibco/Tolco Fig. 1

2. Adjustable Swivel Ring Type:

Service: Bare Metal Pipe - 4 inches and Smaller

Acceptable Products: Bare Steel Pipe

Anvil Fig. 69  
Cooper/B-Line Fig. B3170NF  
Erico Model FCN  
Nibco/Tolco Fig. 200

D. Support may be fabricated from U-Channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

1. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

E. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

1. Clamp Type:

Service: Bare Metal Pipe

a. Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.

Acceptable Products: Bare Steel Pipe

Unistrut Fig. P1100 or P2500  
Cooper/B-Line Fig. B2000 or B2400  
Nibco/Tolco Fig. A-14 or 2STR



- F. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
1. Beam Clamps:

Acceptable Products:	
Anvil	Fig. 228, 292
Cooper/B-Line	Fig. B3054
Erico	Model 360
Nibco/Tolco	Fig. 329
  2. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
  3. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.
- G. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.
- H. Welding:
1. Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

### 2.3 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

## 2.4 PIPE SLEEVES

- A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- D. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Engineer's design.
- E. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- F. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

## 2.5 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes duct and pipe openings.

## 2.6 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## 2.7 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## 2.8 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

## PART 3 - EXECUTION

### 3.1 FIRE SUPPRESSION SUPPORTS AND ANCHORS

#### A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

#### B. Supports Requirements:

1. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
2. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
3. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

#### C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

#### D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.

2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    - a. The hanger is attached within 6" from a web/chord joint.
    - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
  3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
  4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Spacing of Hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

	<u>Pipe Material</u>	<u>Maximum Spacing</u>
1.	Steel (Std. Weight or Heavier – Liquid Service):	
	1-1/4" & under	7'-0"
	1-1/2"	9'-0"
	2"	10'-0"
	2-1/2"	11'-0"
	3"	12'-0"
	4" & larger	12'-0"
2.	Installation of hangers shall conform to MSS SP-58 and applicable NFPA standards.	

**END OF SECTION 21 05 29**

## SECTION 21 05 53 - FIRE SUPPRESSION IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Identification of products installed under Division 21.

#### 1.2 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. 3M, Bunting, Calpico, Craftmark, Emedco, Kolbi Industries, Seton, W.H. Brady, Marking Services.

#### 2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<u>O.D. of Pipe or insulation</u>	<u>Marker Length</u>	<u>Size of Letters</u>
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

Plastic tags may be used for outside diameters under 3/4".

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.

- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
  - 1. All valves (except shutoff valves at equipment) shall have numbered tags.
  - 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
  - 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
  - 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
  - 5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
  - 6. Number all tags and show the service of the pipe.
  - 7. Add to existing valve directory listing all valves, with respective tag numbers, uses and locations.
- D. Pipe Markers:
  - 1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
  - 2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
  - 3. Apply markers and arrows in the following locations where clearly visible:
    - a. At each valve.
    - b. On both sides of walls that pipes penetrate.
    - c. At least every 20 feet along all pipes.
    - d. On each riser and each leg of each "T" joint.
    - e. At least once in every room and each story traversed.

3.2 SCHEDULE

- A. Pipes to be marked:

Pipe Service	Lettering Color	Background Color
Fire Protection Water	White	Red

**END OF SECTION 21 05 53**

## SECTION 21 13 00 - FIRE PROTECTION SYSTEMS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pipe, Fittings, Valves, and Connections for Fire Protection System.
- B. Wet-Pipe Sprinkler System.

#### 1.2 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Conform to ASME Code.
- B. Equipment and Components: Bear UL label or marking.
- C. Valves: Bear UL label or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.
- D. Specialist Firm: Company specializing in sprinkler systems with minimum three years experience.
- E. Sprinkler design drawings submitted by the Contractor shall be prepared by a NICET Water-Based Fire Protection Systems Layout Level III or Level IV designer or PE, and signed and sealed by a Professional Engineer licensed in the state where the project is located.

#### 1.3 REFERENCES

- A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- E. ANSI/ASME B16.9 - Factory-made Wrought Steel Butt-Welding Fittings.
- F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
- G. ANSI/ASTM A47 - Malleable Iron Castings.
- H. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.
- I. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.
- J. AWS B2.2 - Standard for Brazing Procedure and Performance Qualification.
- K. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- L. MSS SP-73 - Brazing Joints for Wrought and Cast Copper Alloy Solder Joint and Pressure Fittings.

- M. NFPA 101 - Life Safety Code,
- N. NFPA 13 - Installation of Sprinkler Systems.
- O. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- P. UL - Underwriter's Laboratory Fire Protection Equipment Directory.

#### 1.4 SUBMITTALS

- A. Submit shop drawings per Section 21 05 00. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.
- B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.
- C. Submit detailed working drawings and obtain review of them in the following order:
  - 1. Engineer/Architect.
  - 2. State Fire Marshal/Authority Having Jurisdiction
  - 3. Owner's Insurance Company
  - 4. Architect/Engineer

Begin construction after all approvals are received.
- D. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.
- E. Provide the Owner with one copy of NFPA 25. *Standard for the Inspection Testing and Maintenance of Water-based Fire Protection Systems.*

#### 1.5 EXTRA STOCK

- A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store valves and sprinklers in shipping containers, with labels in place.
- B. Provide temporary protective coating on iron and steel valves.
- C. Maintain temporary end caps and closures in place until installation.

#### 1.7 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves to General Contractor for placement in walls and floors. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.

#### 1.8 SYSTEM DESCRIPTION

- A. System shall cover building areas noted.



- B. System shall interface with building fire alarm system.
- C. Extend existing wet pipe sprinkler system from adjacent City Center Building to NFPA 13 and building code requirements as required by Owner's insurance company and as shown on the drawings.

#### 1.9 REGULATORY REQUIREMENTS

- A. All material, equipment, and installation shall be approved by the Authorities Having Jurisdiction and the Owner's Insurance Company.
- B. The Authorities Having Jurisdiction and the Owner's Insurance Company shall have precedence over the drawings and specifications in case of discrepancies.
- C. The entire installation shall comply with all applicable codes.

#### 1.10 SYSTEM DESIGN

- A. Design and install a complete, hydraulically calculated wet-pipe sprinkler system for the entire building.
- B. Provide all required equipment and accessories.
- C. System shall include a 5 psi allowance for future decrease in available pressure and an allowance for inside and outside hose streams.
- D. Provide monitor switches on all shutoff valves.
- E. Install sprinkler riser in location shown on drawings or as approved by the Architect/Engineer.
- F. Provide flow switch as indicated on drawings.

#### 1.11 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 21 05 00 for required fire protection systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

#### 1.12 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturers' operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.

#### 1.13 JOB CONDITIONS

- A. Fire Protection Contractor shall determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.
- B. Pipe sizing shown on drawings for service entrance and main risers is preliminary for coordination purposes only. Contractor is responsible for final sizing from hydraulic calculations.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

#### A. Steel Pipe (Inside Building-Above Grade):

1. Pipe: 2" and Under - Schedule 40, black steel, ASTM A53. Threaded and coupled or flanged.
2. Joints: 2" and under - screwed or flanged.
3. Fittings: Screwed - cast iron, 125 lb., black, ANSI/ASME B16.4 or malleable iron, 150 lb., black, ANSI/ASME B16.3. Flanged-cast iron, 125 lb., ANSI/ASME B16.1.

#### B. Steel Pipe (Inside Building-Above Grade):

1. Pipe: 2-1/2" and Over - Schedule 10, black steel, grooved, ASTM A135.
2. Joints: Mechanically coupled grooved.
3. Fittings: 500 lb. WOG, black, malleable iron, ASTM A47.
4. Plain end fittings and couplings are not acceptable.

### 2.2 UNIONS AND COUPLINGS

#### A. Unions: 175 psi malleable iron for threaded ferrous piping.

#### B. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular and longitudinal deflection; "C" shaped composition sealing gasket, steel bolts, nuts, and washers. 175 psi, ASTM A47. Plain end fittings and couplings are not acceptable. Rolled groove couplings for Schedule 10 pipe. Cut groove couplings for Schedule 40 pipe. Couplings shall be enamel coated for wet systems. Acceptable Manufacturers: Victaulic, ITT, Grinnell, Central, Star Fittings.

#### C. Coupling gaskets for wet systems shall be Grade "E" EDPM Type A.

### 2.3 VALVE OPERATORS

#### A. Provide gear operators for butterfly valves.

### 2.4 VALVE CONNECTIONS

#### A. Provide all connections to match pipe joints. Valves shall be same size as pipe.

### 2.5 EQUIPMENT

#### A. Equipment shall be as scheduled on the drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION - PIPING

#### A. General Installation Requirements:

1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.
2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.
3. Die cut screw joints with full cut standard taper pipe threads.
4. Coat threads with pipe joint compound or wrap with Teflon tape.
5. Locate piping to minimize obstruction of other work.
6. Route piping in concealed spaces above finished ceiling.
7. Use full and double lengths of pipe wherever possible.
8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.
9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
10. Comply with manufacturer's installation instructions.

#### B. Steel Piping:

1. In steel piping, main sized saddle branch connections or direct connection of branches to main is permitted if main is one pipe size larger than the branch for up to 6" mains and if main is two pipe sizes larger than branch for 8" and larger mains. Do not project branch pipes into main pipes.

#### C. Wall/Floor Penetration:

1. Provide sleeves when penetrating floors and walls.
2. Fire seal all pipe and sleeve penetrations (both wall and floor) to maintain fire separation required without restraining pipe.

#### D. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

- E. Hangers and Supports:
  - 1. Provide hangers and supports as required by NFPA 13 and UL, with the following exceptions:
    - a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
    - b. Do not install fasteners to carry the load in tension, unless absolutely necessary.

- F. Exposed Piping:
  - 1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.

### 3.2 INSTALLATION - EQUIPMENT

- A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.
- B. Test Valves:
  - 1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.
- C. Sprinklers:
  - 1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
  - 2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
  - 3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
  - 4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.

### 3.3 SYSTEMS CLEANING AND TESTING

- A. General Requirement:
  - 1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.
- B. Interior Piping:
  - 1. Verify adequate water flow at the inspector's test connection.
  - 2. Flush all interior piping to remove scale and other foreign material before placing system into service.
  - 3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig in excess of the normal system working pressure for systems subjected to pressures in excess of 150 psig. Maintain test pressure for 2 hours without loss of pressure.

C. Fire Alarm System:

1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.
2. Adjust all monitor switches for proper operation.

**END OF SECTION 21 13 00**



## SECTION 22 05 00 - BASIC PLUMBING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in the specification section.

#### 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make his portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

#### 1.3 COORDINATION DRAWINGS

##### A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested

areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. KJWW will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by KJWW. KJWW will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:



1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

#### 1.4 QUALITY ASSURANCE

##### A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

##### B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

##### C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Joliet Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.
4. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
7. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Examination of Drawings:

1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and

the word "provide" shall mean to supply for use and connect complete and ready for operation.

- a. Any item listed as furnished shall also be installed, unless otherwise noted.
- b. Any item listed as installed shall also be furnished, unless otherwise noted.

F. Field Measurements:

- 1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

G. Electronic Media/Files:

- 1. Construction drawings for this project have been prepared utilizing Revit.
- 2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
- 3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
- 4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
- 5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
- 6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
- 7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
- 8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

1.5 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

- 1. Submittals List:

<b><u>Referenced Specification Section</u></b>	<b><u>Submittal Item</u></b>
22 14 29 Refer to drawings	Sump Pumps Plumbing Material List Items

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
1. Transmittal: Each transmittal shall include the following:
    - a. Date
    - b. Project title and number
    - c. Contractor's name and address
    - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
    - e. Description of items submitted and relevant specification number
    - f. Notations of deviations from the contract documents
    - g. Other pertinent data
  2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
    - a. Date
    - b. Project title and number
    - c. Architect/Engineer
    - d. Contractor and subcontractors' names and addresses
    - e. Supplier and manufacturer's names and addresses
    - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
    - g. Description of item submitted (using project nomenclature) and relevant specification number
    - h. Notations of deviations from the contract documents
    - i. Other pertinent data
    - j. Provide space for Contractor's review stamps
  3. Composition:
    - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
    - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
    - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
  4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
  5. Contractor's Approval Stamp:
    - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
    - b. Unstamped submittals will be rejected.

- c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 22 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 22 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

1.6 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
  1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
  2. Submit in Excel format.
  3. Support values given with substantiating data.
- C. Preparation:
  1. Itemize the cost for each of the following:
    - a. Overhead and profit.
    - b. Bonds.
    - c. Insurance.
    - d. General Requirements: Itemize all requirements.

2. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
    - a. Contractor's own labor forces.
    - b. All subcontractors.
    - c. All major suppliers of products or equipment.
  3. Break down all costs into:
    - a. Material: Delivered cost of product with taxes paid.
    - b. Labor: Labor cost, excluding overhead and profit.
  4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
    - a. Excavation and backfill for underground piping systems inside the building.
    - b. Underground piping systems inside the building (sanitary, storm, etc.) listed separately. Break down the material and labor for each piping system based on geography (building, floor, wing and/or phase).
    - c. Each aboveground piping system (sanitary, storm, domestic water, etc.). Break down the material and labor for each piping system based on geography (building, floor, wing and/or phase).
    - d. Pipe insulation with separate material and labor line items for each piping system listed above.
    - e. Each piece of equipment requiring shop drawings (e.g., backflow preventer, water heater, water softener, etc.) using the project nomenclature (BFP-1, WH-1, WS-1, etc.).
    - f. Each plumbing fixture (e.g., WC, lavatory, sink, etc.). Multiple units of the same type can be listed together, provided quantities are also listed so unit costs can be determined.
    - g. Water balancing
    - h. Record drawings
    - i. Punchlist and closeout
- D. Update Schedule of Values when:
1. Indicated by Architect/Engineer.
  2. Change of subcontractor or supplier occurs.
  3. Change of product or equipment occurs.

#### 1.7 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

#### 1.8 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful



conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

- B. Keep all bearings properly lubricated.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

#### 1.9 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

#### 1.10 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

#### 1.11 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.

- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

## PART 2 - PRODUCTS

NOT APPLICABLE

## PART 3 - EXECUTION

### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employee and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:
  - 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
  - 2. The Contractor shall do all excavating, filling, backfilling and compacting associated with his work.
- B. Excavation:
  - 1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
  - 2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
  - 3. Trim bottom and sides of excavations to grades required for foundations.
  - 4. Protect excavations against frost and freezing.

5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
  6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
  7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
  8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.
- C. Dewatering:
1. Contractor shall furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.
- D. Underground Obstructions:
1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
  2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.
- E. Fill and Backfilling:
1. No rubbish or waste material is permitted for fill or backfill.
  2. Provide all necessary sand for backfilling.
  3. Dispose of the excess excavated earth as directed.
  4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris or earth with a high void content.
  5. Backfill all trenches and excavations immediately after installing pipes, or removal of forms, unless other protection is provided.
  6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.
  7. Lay all piping on a compacted bed of sand at least 3 inches deep. Backfill around pipes with sand, 6 inch layers, and compact each layer.
  8. Use sand for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand backfill to 6 inches above the top of the pipe.
  9. Place all backfill above the sand in uniform layers not exceeding 6 inches deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.

10. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

### 3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
  - a. Pipe insulation is installed and fully sealed.
  - b. Pipe wall penetrations are sealed.
  - c. Pipe identification and valve tags are installed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.

2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
  3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including marked-up or reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
  4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

### 3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div22.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

### 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
  1. Explanation of all system flow diagrams.
  2. Maintenance of equipment.
- E. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
  1. Domestic Hot Water System - 4 hours.
- G. Operating Instructions:
  1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
  2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.7 SYSTEM COMMISSIONING

- A. The plumbing systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.
- B. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty

period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.8 RECORD DOCUMENTS

- A. The following paragraph supplements Division 1 requirements:

Contractor shall maintain at the job site a separate and complete set of plumbing drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the plumbing systems.

- B. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- C. Before completion of the project, a set of reproducible plumbing drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- D. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- E. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- F. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

### 3.9 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.



- E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- F. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
  - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
  - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

### 3.10 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### 3.11 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

**END OF SECTION 22 05 00**

**READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION**

In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

- 1. Penetrations fire sealed and labeled in accordance with specifications.
- 2. All pumps operating and balanced.
- 3. All plumbing fixtures installed and caulked.
- 4. Pipe insulation complete, pipes labeled and valves tagged.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

\* \* \* \* \*

## SECTION 22 05 03 - THROUGH PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

#### 1.3 REFERENCES

- A. UL 723 - Surface Burning Characteristics of Building Materials
- B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- D. Warnock Hersey - Directory of Listed Products
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- G. NFPA 5000 – Building Construction Safety Code

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings:
  - a. Floor penetrations located outside wall cavities.
  - b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.6 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  1. 3M; Fire Protection Produces Division.
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk.
  4. Tremco; Sealant/Weatherproofing Division.
  5. Johns-Manville.
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems

### 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.

- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

- 1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated  
 F Rating = Floor/Wall Rating  
 T Rating = Floor/Wall

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

- 2. Non-Combustible Framed Walls - 1 or 2 Hour Rated  
 F Rating = Wall Rating  
 T Rating = 0

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

- 3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated  
 F Rating = Wall/Floor Rating  
 T Rating (Floors) = Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999

<u>Penetrating Item</u>	<u>UL System No.</u>
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

#### 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.

- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### 3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### 3.4 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

**END OF SECTION 22 05 03**





## **SECTION 22 05 05 - PLUMBING DEMOLITION FOR REMODELING**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Mechanical demolition.
- B. Cutting and Patching.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS AND EQUIPMENT**

- A. Materials and equipment shall be as specified in individual Sections.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.
- B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.
- C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.
- D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.
- E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.
- F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.
- G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

#### **3.2 PREPARATION**

- A. Disconnect plumbing systems in walls, floors, and ceilings scheduled for removal.

#### **3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK**

- A. Demolish and extend existing plumbing work under provisions of Division 2 and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.

- C. Remove abandoned piping to source of supply and/or main lines.
- D. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.
- E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Extend existing installations using materials and methods compatible with existing installations, or as specified.
- H. Remove unused sections of domestic water piping back to mains and cap. Capped pipe shall be less than 2 feet from main to prevent "dead legs".
- I. Temporarily cap all openings to the sanitary and vent system to prevent odor from entering the work area and building.

#### 3.4 CUTTING AND PATCHING

- A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 22 05 29 for additional requirements.
- B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.
- C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.
- D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

#### 3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.
- C. PLUMBING ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

#### 3.6 SPECIAL REQUIREMENTS

- A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction or as noted on the drawings. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

- B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

**END OF SECTION 22 05 05**



## **SECTION 22 05 13 - MOTORS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Single Phase and Three Phase Electric Motors.

#### **1.2 REFERENCES**

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- E. ANSI/NEMA MG 1 - Motors and Generators.
- F. ANSI/NFPA 70 - National Electrical Code.
- G. Energy Independence and Security Act of 2007.

#### **1.3 DELIVERY, STORAGE, AND HANDLING**

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

#### **1.4 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

#### **1.5 QUALIFICATIONS**

- A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL CONSTRUCTION AND REQUIREMENTS**

- A. Refer to the drawings for required electrical characteristics.
- B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.

- D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.
- F. Each contractor shall set all motors furnished by him.
- G. All motors shall have a minimum service factor of 1.15.
- H. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.
- I. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.
- J. Motors for pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control.

2.2 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

- A. All motors, unless exempted by EPA legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0

- B. Motor nameplate shall be noted with the above ratings.

2.3 MOTOR DRIVEN EQUIPMENT

- A. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
- B. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not

acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

**END OF SECTION 22 05 13**





## SECTION 22 05 29 - PLUMBING SUPPORTS AND ANCHORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Sleeves and Seals.
- C. Flashing and Sealing of Equipment and Pipe Stacks.
- D. Cutting of Openings.
- E. Escutcheon Plates and Trim.

#### 1.2 REFERENCES

- A. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

#### 1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

### PART 2 - PRODUCTS

#### 2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2" and smaller	3/8"	3/8"
2-1/2" through 3-1/2"	1/2"	1/2"
4" and 5"	5/8"	1/2"

Column #1: Cast iron pipe.

Column #2: Copper and plastic pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

#### 2.2 PIPE HANGERS AND SUPPORTS

- A. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58 and 127 (where applicable).
- B. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
- C. On all insulated piping, provide a semi-cylindrical metallic shield and fire resistant vapor barrier jacket.

- D. As an alternative to separate pipe insulation insert and saddle, properly sized integral rigid insulation sections may be used for this application.

Acceptable Products:

Cooper/B-Line - Fig. B3380 through B3384  
 Pipe Shields - A1000, A2000  
 Erico - Model 124, 127

- E. Support and laterally brace vertical pipes at every floor level in multi-story structures, and more frequently when required by applicable codes (the Illinois Plumbing Code requires 10 foot maximum spacing for support of copper risers), but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings or lugs welded to the pipe. Provide sufficient flexibility to accommodate expansion and contraction without compromising fire barrier penetrations and other fixed takeoff locations.

Acceptable Products:

Anvil - Fig. CT121  
 Cooper/B-Line - Fig. B3373CT  
 Erico - Model 510  
 Nibco/Tolco - Fig. 82

- F. Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Insulate over mounts.

Acceptable Products: Mason RBA, RCA, or BR.

- G. Unless otherwise indicated, hangers shall be as follows:

1. Clevis Type:

Service: Bare Metal Pipe  
 Rigid Plastic Pipe  
 Insulated Cold Pipe  
 Insulated Hot Pipe - 3 inches & Smaller

Acceptable Products: Bare Steel, Plastic  
 or Insulated Pipe

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Anvil Fig. 260  
 Cooper/B-Line Fig. 3100  
 Erico Model 400  
 Nibco/Tolco Fig. 1

2. Adjustable Swivel Ring Type:

Service: Bare Metal Pipe - 4 inches and Smaller

Acceptable Products: Bare Steel Pipe

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Anvil Fig. 69  
 Cooper/B-Line Fig. B3170NF  
 Erico Model FCN  
 Nibco/Tolco Fig. 200

- H. Support may be fabricated from U-Channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

1. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

I. Unless otherwise indicated, pipe supports for use with struts shall be as follows:

1. Clamp Type:

Service: Bare Metal Pipe  
Rigid Plastic Pipe  
Insulated Cold Pipe  
Insulated Hot Pipe - 3 inches and smaller

- a. Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.

Acceptable Products: Bare Steel, Plastic  
or Insulated Pipe

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Unistrut	Fig. P1100 or P2500
Cooper/B-Line	Fig. B2000 or B2400
Nibco/Tolco	Fig. A-14 or 2STR

J. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

1. Beam Clamps:

Acceptable Products:

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Anvil	Fig. 228, 292
Cooper/B-Line	Fig. B3054
Erico	Model 360
Nibco/Tolco	Fig. 329

2. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

3. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

K. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.

L. Welding:

1. Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

## 2.3 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

## 2.4 PIPE SLEEVES AND LINTELS

- A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- G. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- H. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

## 2.5 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

## 2.6 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## 2.7 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## 2.8 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

# PART 3 - EXECUTION

## 3.1 PLUMBING SUPPORTS AND ANCHORS

- A. General Installation Requirements:
  - 1. Install all items per manufacturer's instructions.
  - 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
  - 3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- B. Supports Requirements:
  - 1. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
  - 2. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
  - 3. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.
- C. Pipe Requirements:
  - 1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection,

- swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
  3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
  4. Piping shall not introduce strains or distortion to connected equipment.
  5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
  6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
  7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
  8. Provide at least one hanger adjacent to each joint in cast iron soil pipe, grooved end steel pipe with mechanical couplings, and glass pipe.
- D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
  2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    - a. The hanger is attached within 6" from a web/chord joint.
    - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
  3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
  4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

- H. Spacing of Hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

	<u>Pipe Material</u>	<u>Maximum Spacing</u>
1.	Hard Drawn Copper & Brass (Liquid Service):	
	3/4" and under	5'-0"
	1"	6'-0"
	1-1/4"	7'-0"
	1-1/2"	8'-0"
	2"	8'-0"
	2-1/2"	9'-0"
	3"	10'-0"
2.	Cast Iron Soil Pipe - All Sizes:	
	Over 5' pipe lengths	10'-0"
	Less than 5' pipe lengths	5'-0"
	Support all direction changes and branch connections.	
3.	Rigid Plastic Pipe:	
	a. Space hangers at 4'-0" maximum centers.	
4.	Installation of hangers shall conform to MSS SP-58 and the applicable Plumbing Code.	

**END OF SECTION 22 05 29**





## SECTION 22 05 53 - PLUMBING IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Identification of products installed under Division 22.

#### 1.2 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. 3M, Bunting, Calpico, Craftmark, Emedco, Kolbi Industries, Seton, W.H. Brady, Marking Services.

#### 2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<u>O.D. of Pipe or insulation</u>	<u>Marker Length</u>	<u>Size of Letters</u>
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

Plastic tags may be used for outside diameters under 3/4".

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.

- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
1. All valves (except shutoff valves at equipment) shall have numbered tags.
  2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
  3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
  4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
  5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
  6. Number all tags and show the service of the pipe.
  7. Provide one 36" x 24" minimum Plexiglas framed piping schematic showing valve locations with respective tag numbers. Mount directory in location chosen by the Architect/Engineer.
- D. Pipe Markers:
1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
  2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
  3. Apply markers and arrows in the following locations where clearly visible:
    - a. At each valve.
    - b. On both sides of walls that pipes penetrate.
    - c. At least every 20 feet along all pipes.
    - d. On each riser and each leg of each "T" joint.
    - e. At least once in every room and each story traversed.
- E. Equipment:
1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
  2. Provide engraved plastic tags at all hydronic or steam system makeup water meters.
  3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

### 3.2 SCHEDULE

#### A. Pipes to be marked:

<u>Pipe Service</u>	<u>Lettering Color</u>	<u>Background Color</u>
Domestic Cold Water	White	Green
Domestic Hot Water - 115°F	Black	Yellow
Domestic Hot Water - 140°F	Black	Yellow
Domestic Hot Water Circulating - 115°F	Black	Yellow
Domestic Hot Water Circulating - 140°F	Black	Yellow
Sanitary Sewer	Black	Yellow
Vent	Black	Yellow

**END OF SECTION 22 05 53**



## SECTION 22 07 19 - PLUMBING PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Insulation Jackets.

#### 1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

#### 1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ASTM E84 - Surface Burning Characteristics of Building Materials.
- C. NFPA 255 - Surface Burning Characteristics of Building Materials.
- D. UL 723 - Surface Burning Characteristics of Building Materials.
- E. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

### PART 2 - PRODUCTS

#### 2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All purpose, white kraft jacket bonded to aluminum foil and reinforced with fiberglass yarn, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
- B. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.35 maximum 'K' value at 75°F; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose white kraft jacket for above grade installations.

#### 2.2 VAPOR BARRIER JACKETS

- A. Kraft reinforced foil vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

## 2.3 JACKET COVERINGS

- A. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. 25/50 maximum flame spread/smoke developed.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

### 3.2 INSTALLATION

- A. General Installation Requirements:

1. Install materials per manufacturer's instructions, building codes and industry standards.
2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
3. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a 180° cylindrical segment the same length as metal shields. Inserts shall be a cellular glass (for all temperature ranges). Factory fabricated inserts may be used. Rectangular blocks, plugs, or wood material are not acceptable. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor.
4. Neatly finish insulation at supports, protrusions, and interruptions.
5. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

6. Shields shall be at least the following lengths and gauges:

	<u>Pipe Size</u>	<u>Shield Size</u>
a.	1/2" to 3-1/2"	12" long x 18 gauge
b.	4"	12" long x 16 gauge

7. All piping and insulation that does not meet 25/50 that is located in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has passed ASTM E84 and/or NFPA 255 testing with a rating of 25/50 or below.
8. On 1" and smaller piping routed through metal wall studs, provide a plastic grommet to protect the piping. The piping shall be insulated between the wall

studs, and the insulation shall butt up to each stud.

- B. Insulated Piping Operating Below 60°F:
  - 1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
  - 2. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.
- C. Insulated Piping Operating Between 60°F and 140°F:
  - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.
- D. Exposed Piping:
  - 1. Locate and cover seams in least visible locations.
  - 2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.

### 3.3 INSULATION

- A. Type A Insulation:
  - 1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
  - 2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
  - 3. Apply insulation with laps on top of pipe.
  - 4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F, seal fitting covers with vapor retarder mastic in addition to tape.
- B. Type C Insulation:
  - 1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.
  - 2. Insulate fittings with prefabricated fittings.

### 3.4 JACKET COVER INSTALLATION

- A. Plastic Covering:
  - 1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.

2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. Use plastic insulation covering on all exposed pipes including, but not limited to:
  - a. All exposed piping below 8'-0" above floor.
  - b. All piping in mechanical rooms and/or tunnels that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)

### 3.5 SCHEDULE

Piping System	Insulation Type/Thickness
A. Domestic Hot Water & Circulating - up to 140°F	
Up to 1-1/2" Pipe Size	A / 1"
Above 1-1/2" Pipe Size	A / 1-1/2"
B. Domestic Cold Water	A / 1"
C. Plumbing Vents Within 10' from Roof Penetration	A / 1/2"
D. Insulation Inserts at hangers	C - Match pipe insulation thickness

**END OF SECTION 22 07 19**



## SECTION 22 09 00 - INSTRUMENTATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Thermometers.
- B. Test Plugs.

#### 1.2 REFERENCES

- A. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.
- B. ASTM E1 - Specification for ASTM Thermometers.

### PART 2 - PRODUCTS

#### 2.1 THERMOMETERS

- A. Alcohol/Spirit Filled Type:
  - 1. 9" long phenolic case, steel stem, accuracy of 1% full scale. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
  - 2. Select thermometer for appropriate temperature range.
  - 3. Stem lengths as required for application with minimum insertion of 3-1/2".
  - 4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Wells shall extend through insulation.
  - 5. Acceptable Manufacturer: Marsh, Miljoco, Trerice, Weiss, Weksler, Wika.

#### 2.2 TEST PLUGS

- A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.
- B. Provide extended units for all plugs installed in insulated piping.
- C. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2" diameter pressure gauge with 0-100 psi range, one gauge adapter with 1/8" probes, two 1-1/2" dial thermometers with 0° to 220°F and -25°F to 125°F ranges and 5" stems.
- D. Acceptable Manufacturers: Sisco, Flow Design, or Peterson Equipment.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. General Installation Requirements:
  - 1. Install per manufacturer's instructions.

2. Install thermometers in locations where they are easily read from normal operating level.
3. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Thermometers:

1. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.

**END OF SECTION 22 09 00**

## SECTION 22 10 00 - PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Domestic Water Piping System.
- D. Sanitary Drainage and Vent Piping System.

#### 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.
- D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

#### 1.3 REFERENCES

- A. ANSI/ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
- C. ANSI/ASTM B32 - Solder Metal.
- D. ANSI/ASTM D2466 - PVC Plastic Pipe Fittings, Schedule 40.
- E. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.
- F. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- G. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- H. ANSI/AWWA C153 - Compact Ductile Iron Fittings 3" through 48", for Water and Other Liquids.
- I. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- J. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- K. ASTM B88 - Seamless Copper Water Tube.
- L. ASTM B306 - Copper Drainage Tube (DWV).
- M. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

- N. ASTM C1540 - Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- O. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- P. ASTM D1785 - Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- Q. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- R. ASTM D2665 - PVC DWV Pipe & Fittings.
- S. ASTM D3033 - Type PSP (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
- T. ASTM D3034 - Type PSM (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
- U. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
- V. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- W. AWWA C651 - Disinfecting Water Mains.
- X. NFPA 24 - Private Fire Service Mains and Their Appurtenances.
- Y. NSF - National Sanitation Foundation

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

#### 1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 22 05 00 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

### PART 2 - PRODUCTS

#### 2.1 COLD WATER HOT WATER HOT WATER CIRCULATION

- A. Design Pressure: 175 psi.  
Maximum Design Temperature: 200°F.
- B. Piping - All Sizes:
  - 1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
  - 2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
  - 3. Fittings: Wrought copper solder joint, ANSI B16.22.

C. Shutoff Valves:

1. Ball Valves:

a. BA-1:

- 1) 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-255-FB-P-UL BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

NOTES:

- a) Provide extended shaft for all valves in insulated piping.
- b) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F. Solid extended shaft is not required on valves with lock out trim.

D. Check Valves:

1. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #G-5000, Nibco T-413B.

E. Strainers:

1. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777.
2. ST-7: 2-1/2" thru 8", bronze body, flanged ends, flanged cover, 150# steam, 225# CWP. Mueller Steam Specialty Co. #851.

2.2 SANITARY DRAINAGE  
SANITARY VENT

A. Design Pressure: Gravity  
Maximum Design Temperature: 180°F

B. Piping - All Sizes:

1. Pipe and Fittings: Standard weight cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF Certified, CISPI Trademark.
2. Joints: Compression gasket, ASTM C564 or lead and oakum, ASTM B29.
3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

- C. Piping - 1-1/4" through 16" (Maximum Design Temperature: 140°F):
1. Pipe: Schedule 40 rigid, unplasticized PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
  2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
  3. Fittings: Unplasticized PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.
  4. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed or in return air plenums.
  5. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.
- D. Vent Flashing: Flash vents with premolded EPDM pipe flashing cones for single-ply membrane roofs.

### 2.3 SANITARY – PUMPED (ABOVE GROUND)

- A. Piping - 4" and Under:
1. Pipe: Standard weight galvanized steel, threaded and coupled, ASTM A53.
  2. Joints: Screwed.
  3. Fittings: Galvanized cast iron screwed drainage type, ANSI B16.12, long radius.
- B. Shutoff Valves:
1. Ball Valves:
    - a. BA-1A: 2-1/2" and 3", 150 psi saturated steam, 275 psi CWP ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

#### NOTES:

- 1) Provide extended shaft for all valves in insulated piping.

- C. Check Valves:
1. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #B-5000, Nibco T-413-Y.

### 2.4 UNIONS

- A. Copper pipe - wrought copper fitting - ground joint.
- B. Black Steel (Schedule 40) Pipe - malleable iron, ground joint, 150 psi, bronze to bronze seat.

- C. Galvanized Steel Pipe - galvanized malleable iron, ground joint, 150 psi, bronze to bronze seat.

2.5 AIR VENTS

- A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.
- B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

2.6 STRAINERS

- A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

Pipe Size	1/4" - 2"
water	3/64"

- B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.
- C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.7 RELIEF VALVES

- A. RV-4: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210°F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

2.8 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units which sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Flow rate of 0.5 GPM or larger: Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design "Accusetter", Preso "B+", Armstrong "CVB", Bell & Gossett "Circuit Setter Plus", Griswold "Quickset", Gerand "Balvalve Venturi" or Nibco Globe Style balancing valve.
- D. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.9 DRAIN VALVES

- A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

## 2.10 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn shutoff valves opening to atmosphere and installed in domestic water piping over 120°F.

## 2.11 VALVE OPERATORS

- A. Provide handwheels for gate valves and gear operators for butterfly valves.

## 2.12 VALVE CONNECTIONS

- A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

# PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Install all products per manufacturer's recommendations.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and dirt, on inside and outside, before assembly.
- D. Connect to equipment with flanges or unions.
- E. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.
- F. Existing building sewers or building drains which are shown on the documents to be reused shall be inspected and recorded by closed circuit television for their condition. Report findings back to the Architect, Engineer, and Owner before proceeding with work so any necessary rework can take place if needed.

## 3.2 TESTING PIPING

- A. Sanitary Drainage:  
Sanitary Vent:
  - 1. Test all piping with water to prove tight.
  - 2. Test piping before insulation is applied.
  - 3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
  - 4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
  - 5. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
  - 6. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.



7. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.

B. Hot Water:  
Cold Water:

1. Test pipes underground or in chases and walls before piping is concealed.
2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen.
4. Hold test pressure for at least 2 hours.
5. Test to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.

C. All Other Piping:

1. Test piping at 150% of normal operating pressure.
2. Piping shall hold this pressure for one hour with no drop in pressure.
3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.
4. Drain and clean all piping after testing is complete.

### 3.3 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative with regard to specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.

2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

### 3.4 INSTALLATION

#### A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
7. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

#### B. Installation Requirements In Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

#### C. Valves/Fittings and Accessories:

1. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: Back-to-back rooms in no more than two adjacent rooms.
2. Provide clearance for installation of insulation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.
5. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.
6. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

7. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

D. Underground Piping:

1. Lay all underground piping in trenches. Provide and operate pumping equipment to keep trenches free of water.
2. For all underground piping, provide a foundation (the layer below the bedding) if the trench bottom is unstable. Lay underground plastic piping on 4" to 6" of sand bedding. When the trench is in rock, lay underground metallic piping on 6" of sand bedding. Provide recessed areas for pipe bells and joints. After joints are made, any misalignment in elevation shall be corrected by tamping sand around the pipe. Backfill with sand in uniform layers not over 6" deep to the spring line of all underground pipes, and carefully compact each layer to 90 percent Standard Proctor density. Backfill with sand up to 6" above pipe for landscaped areas. Remaining backfill may be soil. Under paving and buildings, the remaining backfill shall be sand and compacted to 98 percent Standard Proctor density.
3. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
4. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
5. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Architect/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
6. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.

E. Sanitary Piping:

1. Install all sanitary piping inside the building with a slope of at least the following:

<u>Pipe Size</u>	<u>Minimum Slope</u>
3" and under	- 0.25" per foot
4" and over	- 0.125" per foot

### 3.5 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.

- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.
- D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
- E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.
- F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- G. Provide flanges or unions at all final connections to equipment, traps and valves.
- H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.
- I. Use full and double lengths of pipe wherever possible.
- J. Unless otherwise indicated, install all piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or equipment.
- K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- L. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Provide and operate sufficient pumping equipment to maintain excavations, trenches and pits free of water. Dispose of pumped water so operation areas and other facilities are not flooded. Pipe laying shall follow excavating as closely as possible.
- M. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.

### 3.6 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal water and compressed air lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.
- B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.
- C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.
- D. Provide drip legs at low points and at the base of all risers in compressed air pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

- E. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install compressed air and gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.
- F. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.
- G. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.
- H. All vent and drain piping shall be of same materials and construction for the service involved.

### 3.7 PLUMBING VENTS

- A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.
- B. Extend the high side of the soil and waste stacks at least 12" above roof.
- C. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by General Contractor. Secure top of cone with stainless steel clamp and seal watertight.
- D. Increase vent pipes through the roof two pipe sizes with long increasers located at least 12" below the roof.
- E. In no case shall the vent through the roof be less than 4" in diameter.
- F. Vent pipes through the roof shall be located a minimum of 15 feet from any air intake or exhaust opening on the roof.

### 3.8 BRANCH CONNECTIONS

- A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.
- D. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:
  - 1. Domestic water piping above grade.
- E. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- F. Forged weld-on fittings are limited as follows:
  - 1. Must have at least same pressure rating as the main.
  - 2. Main must be 2-1/2" or larger.
  - 3. Branch line is at least two pipe sizes under main size.

### 3.9 JOINING OF PIPE

#### A. Threaded Joints:

1. Threads shall conform to ANSI B2.1 "Pipe Threads".
2. Ream pipe ends and remove all burrs and chips formed in cutting and threading.
3. Protect plated pipe and valve bodies from wrench marks when making up joints.
4. Apply thread lubricant to male threads as follows:

Vents and Roof Conductors:	Red graphite
All Other Services:	Teflon tape

#### B. Solder Joints:

1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

#### C. Compression Gasket Joints - Sanitary Pipe and Storm Pipe:

1. Joint shall be one piece double seal compression type gasket made specifically for joining cast iron soil pipe. Gasket shall be neoprene, permitting joint to flex as much as 5 degrees without loss of seal. Gasket shall be extra heavy weight class, conforming to ASTM C-564.

#### D. Solvent Weld Joints (PVC):

1. Make joints with a two-step process. Use primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564.

#### E. Elastomeric Gaskets (Sanitary Pipe):

1. Hub and spigot pipe joints with elastomeric gaskets shall be made in accordance with the manufacturer's installation instructions.

### 3.10 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Provide necessary connections at the start of individual sections of mains for adding chlorine.
- B. Before starting work, verify system is complete, flushed and clean.
- C. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

- D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- E. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.
- F. Verify initial chlorination levels by testing at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main.
- G. Maintain disinfectant in system for 24 hours, after which test at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main. If final disinfectant residual tests less than 25 mg/L at any one of the tested outlets, flush the entire system and repeat disinfection and testing procedure.
- H. After final disinfectant residuals test at or above 25 mg/L after a minimum 24-hour duration, flush disinfectant from system at a minimum velocity of 3.0 feet/second until residual is equal to that of incoming water or 1.0 mg/L.
- I. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.

**END OF SECTION 22 10 00**





## SECTION 22 10 30 - PLUMBING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Floor Drains.
- B. Cleanouts.
- C. Traps.
- D. Water Hammer Arresters.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

#### 1.3 REFERENCES

- A. ANSI A112.21.1 - Floor Drains.
- B. ASSE 1010 - Water Hammer Arresters.
- C. PDI WH-201 - Water Hammer Arresters.

#### 1.4 SUBMITTALS

- A. Submit shop drawings under provisions of Section 22 05 00.
- B. Include sizes, rough-in requirements, service sizes, and finishes.

### PART 2 - PRODUCTS

#### 2.1 CLEANOUTS

- A. Provide cleanouts as shown and specified on the drawings as well as required by code.
- B. Coordinate floor cleanout cover with surrounding floor finish. Provide either solid, recessed for tile or terrazzo or carpet marker as applicable.
- C. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
- D. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

#### 2.2 TRAPS

- A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be:
  - 1. Chromium plated cast brass when used with plumbing fixtures or when installed exposed in finished spaces.
  - 2. Insulated at accessible lavatories.

3. Cast iron, deep-seal pattern where concealed above ceiling, below grade or in unfinished areas.
  4. Deep-seal pattern of the same material and/or coating where drainage lines are of special materials or coatings such as polypropylene, PVDF, CPVC, etc.
- B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.
- C. Each trap shall be completely filled with water at the end of construction but before building space turnover to the Owner. All floor drains, floor sinks, trench drains, etc. shall be filled with water and a 1/2" minimum layer of mineral oil.

### 2.3 FLOOR DRAINS AND SINKS

- A. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

### 2.4 WATER HAMMER ARRESTERS AND AIR CHAMBERS

- A. Provide water hammer arresters as shown and specified on the drawings as well as required by code.
- B. ANSI A112.26.1; sized and located in accordance with PDI WH-201, precharged for operation between -100°F and 300°F and maximum 250 psig working pressure.
- C. Air chambers shall meet the requirements of the applicable plumbing code. Minimum 12" long at fixtures and minimum 24" long on risers. Air chambers shall be the same size or larger than the piping it is connected to.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND APPLICATION

- A. Coordinate construction to receive drains at required invert elevations.
- B. Install all items per manufacturer's instructions.
- C. Water Hammer Arresters:
1. Install water hammer arresters in accessible locations. Provide access doors as required. Coordinate type with Architect/Engineer/Owner.
  2. Water hammer arrestors shall be installed in cold and hot water lines upstream of all plumbing fixtures or equipment, with a quick acting valve or multiple quick acting valves. Quick acting valves shall be defined as solenoid actuated valves, manual flush valves, sensor activated faucets and flush valves, squeeze handle spray faucets, and other similar type valves.
  3. Install multiple water hammer arrestors in toilet group branch piping greater than 20 feet in developed length from the cold and hot water mains.
  4. Install air chambers at each fixture not protected by a water hammer arrester.

D. Cleanouts:

1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet in pipe less than 6" size and 100 feet apart in 6" and larger pipes inside the building.
2. Provide cleanouts at bases of all sanitary and storm risers as shown on the drawings and as required by code.
3. Extend cleanouts to the floor with long sweep elbows.
4. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
5. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.

E. Floor Drains:

1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain. Membrane is not required if upper floor construction is single pour, cast-in-place concrete.
2. Use alternate sealing method when installing drains in existing floor slabs.
3. Coordinate sloping requirements with the architectural plans and specifications.

**END OF SECTION 22 10 30**



## **SECTION 22 14 29 - SUMP PUMPS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Sump Pumps.

#### **1.2 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 22 05 00.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Pumps with motors operating above the RPM the pump curves are based on shall have impellers trimmed to deliver GPM and head scheduled.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL**

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Motors shall comply with Section 22 05 13.
- F. The discharge pipe sizes shall meet or exceed the scheduled pump.

#### **2.2 SUMP PUMPS**

- A. Provide pumps as specified on the drawings.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install all products per manufacturer's recommendations.
- B. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings and accessories.
- C. Support piping so weight of piping is not supported by pumps.
- D. Mount control panel on adjacent wall within required distance for cables and wiring. Provide unistrut mounting frame for the control panel if wall space is not available. Properly anchor frame to floor.

- E. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
- F. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.
- G. Set submersible sump pumps on basin/pit floor. Make direct connections to sanitary drainage piping.
- H. Install sump pump basins and connect to drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

**END OF SECTION 22 14 29**

## **SECTION 22 30 00 - PLUMBING EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Water Heaters.

#### **1.2 QUALITY ASSURANCE**

- A. Products and installation of specified products shall conform to recommendations and requirements of the following organizations:
  - 1. American Gas Association (AGA).
  - 2. National Sanitation Foundation (NSF).
  - 3. American Society of Mechanical Engineers (ASME).
  - 4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
  - 5. National Electrical Manufacturers' Association (NEMA).
  - 6. Underwriters' Laboratories (UL).

#### **1.3 REFERENCES**

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/NFPA 70 - National Electrical Code.
- C. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters.

#### **1.4 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 22 05 00.
- B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.
- C. For equipment connected to an electric power source, submit short circuit rating (SCCR) of integrated unit.
- D. Submit manufacturer's installation instructions including control and wiring diagrams.
- E. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.
- F. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

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

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

#### **1.6 REGULATORY REQUIREMENTS**

- A. Water heaters shall conform to AGA, ANSI/NFPA 54, ANSI/NFPA 70, ANSI/UL 1453 as applicable.

- B. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.

## PART 2 - PRODUCTS

### 2.1 WATER HEATERS

- A. All water heaters shall be as scheduled on the drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install all items in accordance with manufacturer's instructions.

### 3.2 WATER HEATER INSTALLATION

- A. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend drain piping full size from relief valve and discharge by positive air gap onto closest floor drain. Discharge pipe material shall be same as domestic water piping.

**END OF SECTION 22 30 00**



## **SECTION 22 40 00 - PLUMBING FIXTURES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. All plumbing fixtures.

#### **1.2 REFERENCES**

- A. ANSI A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- B. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- C. ANSI A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
- D. ANSI A112.19.2M - Vitreous China Plumbing Fixtures.
- E. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- F. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
- G. AHRI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- H. ASSE 1002 - Water Closet Flush Tank Ball Cocks.
- I. Americans with Disabilities Act (ADA), Title III.
- J. The Energy Policy Act (EPAAct) of 2005.

#### **1.3 SUBMITTALS**

- A. Submit product data under provisions of Section 22 05 00. Submittals shall include fixture carriers for record purposes only. Architect/Engineer does not review or approve carriers except for manufacturer.
- B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Wall Hung Fixture Carriers:
  - 1. Material: All Metal, ASME/ANSI A112.6.1M.
  - 2. Acceptable Manufacturers: Zurn, Smith, Wade, Josam, Watts, Mifab.
  - 3. Water closet carrier shall be rated to support 500 lbs. unless noted otherwise on the drawings.
- B. All fixtures shall be as scheduled on the drawings.
- C. All china shall be from the same manufacturer where possible.

- D. All lavatory and sink trim shall be from the same manufacturer where possible.
- E. All fixtures shall be lead free. Faucets, traps, stops, and other fixture accessories shall not contain more lead than allowed per the latest State or Federal Act.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General Installation Requirements:

1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
2. Install each fixture with trap easily removable for servicing and cleaning. Use screwed tailpiece couplings. Connect fixture waste to stack with slip fitting.
3. Provide fixtures with chrome plated rigid or flexible supplies, loose key stops, reducers, and escutcheons.
4. Install components level and plumb.
5. Caulk joint between finish floor and floor mounted fixtures and between finish walls and wall mounted fixtures with silicon caulk. Caulk the joint, between rim and fixture where a fixture builds into a counter top, with caulking compound. Refer to DIVISION 7 for "Caulking" requirements. Color to match fixture.
6. Where there is a possibility of water following pipe brackets, etc., into a wall; caulk escutcheons, space around brackets, etc., to exclude water. Refer to DIVISION 7 for "Caulking" requirements.
7. Refer to Plumbing Material List for fixture mounting heights.

#### B. Wall-Mounted Fixture Requirements:

1. All wall-mounted fixtures shall have compatible carriers designed for their intended service and suitable for the space available and configuration of fixtures. All carriers shall extend to the floor and be anchored to the slab.

#### C. Floor-Mounted Fixture Requirements:

1. Where floor mounted fixtures are installed on a sloped floor, the open void below the fixture shall be grouted, leveled, and caulked to eliminate stress on the fixture and to prevent water migration to the floor below.

#### D. Exposed or Inside Accessible Cabinets Traps, Valve and Pipe Requirements:

1. All traps exposed under fixtures or inside accessible cabinets shall be chrome plated brass.
2. All water or waste piping for plumbing fixtures that is exposed or inside cabinets shall be chrome plated.
3. All exposed flush valves for water closets and urinals shall have a chrome plated hanger to anchor the piping to the wall.

4. All exposed water supply piping and fittings in a finished space to a shower valve, hose bibb, or other water outlet shall be chrome plated.

E. ADA Lavatory Requirements:

1. All handicapped accessible lavatory traps, piping and angle stops shall be installed with an insulating kit specially manufactured for this installation. Armaflex with duct tape is not acceptable.

F. ADA Water Closet Requirements:

1. Handicapped accessible water closet flush valve handles shall face the center of the stall.
2. Coordinate flush valves in handicap accessible locations with grab bars installed by the General Contractor. Make modifications required to flush valve after review by Architect/Engineer.

3.2 ADJUSTING AND CLEANING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
- B. At completion, clean plumbing fixtures, equipment, and faucet aerator screens.

3.3 FIXTURE ROUGH-IN SCHEDULE

- A. Rough-in fixture piping connections in accordance with table on plumbing drawings of minimum sizes for particular fixtures.

**END OF SECTION 22 40 00**



## SECTION 23 05 00 - BASIC HVAC REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 23 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in the specification section.

#### 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make his portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

#### 1.3 COORDINATION DRAWINGS

##### A. Definitions:

- 1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
- 2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested

areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. KJWW will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by KJWW. KJWW will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

#### 1.4 QUALITY ASSURANCE

##### A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

##### B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

##### C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Joliet Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are



not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.

- a. Any item listed as furnished shall also be installed, unless otherwise noted.
- b. Any item listed as installed shall also be furnished, unless otherwise noted.

F. Field Measurements:

- 1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

G. Electronic Media/Files:

- 1. Construction drawings for this project have been prepared utilizing Revit.
- 2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
- 3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
- 4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
- 5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
- 6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
- 7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
- 8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

1.5 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

- 1. Submittals list:

<b>Referenced Specification Section</b>	<b><u>Submittal Item</u></b>
23 05 93	Testing, Adjusting, and Balancing
23 09 00	Controls
23 22 18	Traps and Condensate Return Equipment
23 34 23	Power Ventilators

**Referenced  
Specification  
Section**

**Submittal Item**

23 37 00	Grilles, Registers, and Diffusers
23 74 11	Rooftop Air Conditioning Units
23 81 21	Computer Room Units
23 82 00	Terminal Heat Transfer Equipment

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
  - a. Date
  - b. Project title and number
  - c. Contractor's name and address
  - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - e. Description of items submitted and relevant specification number
  - f. Notations of deviations from the contract documents
  - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
  - a. Date
  - b. Project title and number
  - c. Architect/Engineer
  - d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses
  - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
3. Composition:
  - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:
  - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**
6. Submittal Identification and Markings:
  - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 23 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 23 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

1.6 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
  1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
  2. Submit in Excel format.
  3. Support values given with substantiating data.

C. Preparation:

1. Itemize the cost for each of the following:
  - a. Overhead and profit.
  - b. Bonds.
  - c. Insurance.
  - d. General Requirements: Itemize all requirements.
2. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
  - a. Contractor's own labor forces.
  - b. All subcontractors.
  - c. All major suppliers of products or equipment.
3. Break down all costs into:
  - a. Material: Delivered cost of product with taxes paid.
  - b. Labor: Labor cost, excluding overhead and profit.
4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
  - a. Each piece of equipment requiring shop drawings (e.g., each air handling unit, pump, exhaust fan, etc.). Use the equipment nomenclature (AHU-1, P-1, EF-1, etc.) on the Schedule of Values.
  - b. Each type of small unitary equipment (e.g., FCUs, UHs, CABs, etc.). Multiple units of the same type can be listed together, provided quantities are also listed so unit costs can be determined.
  - c. Each piping system (chilled water, heating water, steam, condensate, etc.). In addition, for larger projects, break down the material and labor for each piping system based on geography (building, floor, and/or wing).
  - d. Each duct system (supply, return, relief, outside air, etc.) listed separately for each unit they serve (AHU-1 supply air ductwork, AHU-1 return air ductwork, etc.).
  - e. Pipe insulation with separate material and labor line items for each piping system listed above.
  - f. Duct insulation with separate material and labor line items for each duct system listed above.
  - g. Temperature controls broken down into material and labor for the following:
    - 1) Engineering
    - 2) Controllers, devices, sensors, etc.
    - 3) Control valves
    - 4) Control dampers
    - 5) Conduit
    - 6) Wiring
    - 7) Programming
    - 8) Commissioning
  - h. Air balancing
  - i. Water balancing
  - j. Record drawings
  - k. Punchlist and closeout

- D. Update Schedule of Values when:
  - 1. Indicated by Architect/Engineer.
  - 2. Change of subcontractor or supplier occurs.
  - 3. Change of product or equipment occurs.

#### 1.7 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

#### 1.8 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
  - 1. Computer Room Units
  - 2. RTU
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

#### 1.9 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

#### 1.10 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

#### 1.11 INSURANCE

- A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

#### 1.12 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

### PART 2 - PRODUCTS

NOT APPLICABLE

### PART 3 - EXECUTION

#### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employee and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the



work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
  - 1. Placing fill over underground and underslab utilities.
  - 2. Covering exterior walls, interior partitions and chases.
  - 3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
  - 1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. Pipe insulation is installed and fully sealed.
    - b. Pipe and duct wall penetrations are sealed.
    - c. Pipe identification and valve tags are installed.
    - d. Main, branch and flexible ducts are installed.
    - e. Diffusers, registers and grilles are installed and connected to ductwork.
  - 2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  - 3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  - 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.

3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including marked-up or reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
  4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
  5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

### 3.4 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    - a. O&M file name: O&M.div23.contractor.YYYYMMDD
    - b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
  5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
  6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
  7. All text shall be searchable.
  8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.
- C. Operation and Maintenance Instructions shall include:
1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
  2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
  3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
  4. Refer to Section 23 09 00 for additional requirements for Temperature Control submittals.
  5. Copy of final approved test and balance reports.
  6. Copies of all factory inspections and/or equipment startup reports.
  7. Copies of warranties.
  8. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
  9. Dimensional drawings of equipment.
  10. Capacities and utility consumption of equipment.
  11. Detailed parts lists with lists of suppliers.
  12. Operating procedures for each system.

13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.
15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

### 3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
  1. Explanation of all system flow diagrams.
  2. Explanation of all air handling systems.
  3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
  4. Maintenance of equipment.
  5. Start-up procedures for all major equipment.
  6. Explanation of seasonal system changes.
  7. Description of emergency system operation.
- E. The Architect/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.
- F. Minimum hours of instruction for each item shall be:
  1. Heating Water System - 8 hours.
  2. Chemical Treatment System - As defined in Section 23 25 00.
  3. Air Handling System(s) - 8 hours.
  4. Computer Room System(s) - 4 hours.
  5. Exhaust System(s) - 4 hours.
  6. Temperature Controls - As defined in Section 23 09 00.
- G. Operating Instructions:
  1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
  2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.6 SYSTEM COMMISSIONING

- A. The mechanical systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor.

This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

- B. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.
- C. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.7 RECORD DOCUMENTS

- A. The following paragraph supplements Division 1 requirements:

Contractor shall maintain at the job site a separate and complete set of mechanical drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the mechanical systems.
- B. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C. Refer to Section 23 09 00 for additional requirements for Temperature Control documents.
- D. Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

### 3.8 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer his color preference and furnish this color.
- E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, storage room, etc., furnished by this Contractor. Equipment furnished with a factory coat of paint and enamel need not be painted, provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- F. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- G. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:
  - 1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
  - 2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.

### 3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### 3.10 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

**END OF SECTION 23 05 00**

## READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

In order to prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All air handling units operating and balanced.
3. All fans shall be operating and balanced.
4. All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.
5. All temperature control systems operating, programmed and calibrated.
6. Pipe insulation complete, pipes labeled and valves tagged.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

\* \* \* \* \*



## SECTION 23 05 03 - THROUGH PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

#### 1.3 REFERENCES

- A. UL 723 - Surface Burning Characteristics of Building Materials
- B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- D. Warnock Hersey - Directory of Listed Products
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- G. NFPA 5000 – Building Construction Safety Code

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings:
  - a. Floor penetrations located outside wall cavities.
  - b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.6 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  1. 3M; Fire Protection Produces Division.
  2. Hilti, Inc.
  3. RectorSeal Corporation, Metacaulk.
  4. Tremco; Sealant/Weatherproofing Division.
  5. Johns-Manville.
  6. Specified Technologies Inc. (S.T.I.)
  7. Spec Seal Firestop Products
  8. AD Firebarrier Protection Systems

### 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.

- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

- 1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated  
 F Rating = Floor/Wall Rating  
 T Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

- 2. Non-Combustible Framed Walls - 1 or 2 Hour Rated  
 F Rating = Wall Rating  
 T Rating = 0

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

- 3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated  
 F Rating = Wall/Floor Rating  
 T Rating (Floors) = Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999

<u>Penetrating Item</u>	<u>UL System No.</u>
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

#### 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.

- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### 3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

**END OF SECTION 23 05 03**



## SECTION 23 05 05 - HVAC DEMOLITION FOR REMODELING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Mechanical demolition.
- B. Cutting and Patching.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be as specified in individual Sections.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.
- B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.
- C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.
- D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.
- E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.
- F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.
- G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

#### 3.2 PREPARATION

- A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.
- C. Existing Heating System: Maintain existing system in service until new system is complete and ready for service. Drain system only to make switchovers and

connections. Obtain permission from the Owner at least 48 hours before partially or completely draining system. Minimize outage duration.

### 3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. Demolish and extend existing mechanical work under provisions of Division 2 and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned ducts and piping to source of supply and/or main lines.
- D. Remove exposed abandoned pipes and ducts, including abandoned pipes and ducts above accessible ceilings. Cut ducts flush with walls and floors, cap duct that remains, and patch surfaces. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.
- E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.
- H. Remove unused sections of supply and return air ductwork back to mains. Patch opening with sheet metal and seal airtight. Patch existing insulation to match existing. Where existing ductwork is to be capped and reused, locate the end cap within 6" of the last branch. End caps shall be 3" pressure class and seal class "A".
- I. Extend existing installations using materials and methods compatible with existing installations, or as specified.

### 3.4 CUTTING AND PATCHING

- A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 23 05 29 for additional requirements.
- B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.
- C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.
- D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

### 3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.



- C. MECHANICAL ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.6 SPECIAL REQUIREMENTS

- A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction or as noted on the drawings. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.
- B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

**END OF SECTION 23 05 05**



## SECTION 23 05 29 - HVAC SUPPORTS AND ANCHORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

#### 1.2 REFERENCES

- A. ANSI/ASME B31.1 - Power Piping.
- B. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

#### 1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

### PART 2 - PRODUCTS

#### 2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2" and smaller	3/8"	3/8"
2-1/2" through 3-5/8"	1/2"	1/2"
4" and 5"	5/8"	1/2"

Column #1: Steel pipe.

Column #2: Copper pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

#### 2.2 FOUNDATIONS, BASES, AND SUPPORTS

- A. Basic Requirements:

- 1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.

- B. Equipment Roof Support (Curbs and Rails):
1. Rooftop equipment such as packaged air handling units, roof hoods and rooftop exhaust fans shall be provided with curbs by the unit manufacturer.
  2. Where not furnished with rooftop equipment, provide prefabricated curbs or rails as follows:
    - a. 12" high above the top surface of the roof (not the roof structure).
    - b. 14 or 18 gauge galvanized sheet metal, as required for the equipment weight.
    - c. Internal reinforcing.
    - d. Pressure treated wood nailer.
    - e. 18 gauge counter flashing completely covering nailer.
    - f. Factory insulated with rigid fiberglass.
  3. Match units to the building roof with either a raised cant to match roof insulation (for built-up roofs), or with no cant (for single-ply roofs).
  4. Where legs of equipment rest on rails, provide 1/4" bent plates 18" long.
  5. Acceptable Manufacturers: Thy, Pate, United, Roof Products Systems or Portals Plus.
  6. Equipment requiring curbs or rails is as follows:
    - a. Condensing Units
- C. Roof Pipe Supports:
1. Provide pre-fabricated roof pipe supports for all piping installed on the roof.
  2. Support shall guide and align pipe while permitting longitudinal expansion.
  3. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
  4. Support shall be UV, corrosion and freeze/thaw resistant.
  5. Support shall include orange paint, reflective safety orange accents or similar markings for increased visibility.
  6. The strut system shall have galvanized aluminum 302 finish.
  7. Acceptable Products: Anvil International HBS-Base Series, Cooper B-Line Dura-Blok, Erico Caddy Pyramid 50, 150, 300, or 600 (to match load), Miro Industries 1.5, 3-R, 4-R or 5-R (to match pipe).
- D. Supports:
1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.

### 2.3 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

### 2.4 ROOF PENETRATIONS

- A. Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots. Material shall match roofing membrane.
- B. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

### 2.5 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

## 2.6 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

## 2.7 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## 2.8 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## 2.9 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

# PART 3 - EXECUTION

## 3.1 HVAC SUPPORTS AND ANCHORS

- A. General Installation Requirements:
  - 1. Install all items per manufacturer's instructions.
  - 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
  - 3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

B. Supports Requirements:

1. Install roof pipe supports to resist wind movement per manufacturer's recommendations. Method of securing base to roof shall be compatible with roofing materials.
2. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
3. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
4. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
  - a. The hanger is attached within 6" from a web/chord joint.
  - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.

3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
  4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Spacing of Hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

	<u>Pipe Material</u>	<u>Maximum Spacing</u>
1.	Steel (Std. Weight or Heavier – Liquid Service):	
	1-1/4" & under	7'-0"
	1-1/2"	9'-0"
	2"	10'-0"
	2-1/2"	11'-0"
	3"	12'-0"
	4" & larger	12'-0"
2.	Hard Drawn Copper & Brass (Liquid Service):	
	3/4" and under	5'-0"
	1"	6'-0"
	1-1/4"	7'-0"
	1-1/2"	8'-0"
3.	Hard Drawn Copper & Brass (Vapor Service):	
	3/4" & under	7'-0"
	1"	8'-0"
	1-1/4"	9'-0"
	1-1/2"	10'-0"
4.	Installation of hangers shall conform to MSS SP-58 and the applicable Plumbing Code.	

**END OF SECTION 23 05 29**



## SECTION 23 05 53 - HVAC IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Identification of products installed under Division 23.

#### 1.2 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. 3M, Bunting, Calpico, Craftmark, Emedco, Kolbi Industries, Seton, W.H. Brady, Marking Services.

#### 2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

<u>O.D. of Pipe or insulation</u>	<u>Marker Length</u>	<u>Size of Letters</u>
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"

Plastic tags may be used for outside diameters under 3/4".

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
- D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.
- E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.
- F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.

- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
1. All valves (except shutoff valves at equipment) shall have numbered tags.
  2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
  3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
  4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
  5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
  6. Number all tags and show the service of the pipe.
  7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
- D. Pipe Markers:
1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
  2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
  3. Apply markers and arrows in the following locations where clearly visible:
    - a. At each valve.
    - b. On both sides of walls that pipes penetrate.
    - c. At least every 20 feet along all pipes.
    - d. On each riser and each leg of each "T" joint.
    - e. At least once in every room and each story traversed.
- E. Equipment:
1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
  2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
  3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the

manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

3.2 SCHEDULE

A. Pipes to be marked:

<u>Pipe Service</u>	<u>Lettering Color</u>	<u>Background Color</u>
Low Pressure Steam	Black	Yellow
Low Pressure Condensate	Black	Yellow
Condensate Drain	Black	Yellow
Natural Gas	Black	Yellow
Refrigerant (Liquid, Suction)	Black	Yellow
All Underground Pipes	Varies	Varies

**END OF SECTION 23 05 53**



## **SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Testing, adjusting, and balancing of air systems.
- B. Testing, adjusting, and balancing of heating systems.
- C. Testing, adjusting, and balancing of plumbing systems.
- D. Measurement of final operating condition of HVAC systems.

#### **1.2 QUALITY ASSURANCE**

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

#### **1.3 REFERENCES**

- A. AABC - National Standards for Total System Balance, 2002.
- B. ADC – Test Code for Grilles, Registers, and Diffusers.
- C. AMCA – Publication 203-90; Field Performance Measurement of Fan Systems.
- D. ASHRAE - 2003 HVAC Applications Handbook; Chapter 37, Testing, Adjusting and Balancing.
- E. ASHRAE/ANSI - Standard 111-1988; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Sixth Edition, 1998.
- G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing, Third Edition, 2002.
- H. TABB – International Standards for Environmental Systems Balance.

#### **1.4 SUBMITTALS**

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.
- B. Submit electronic copy of test reports to the Architect/Engineer for approval. Include index page and indexing tabs.

#### **1.5 REPORT FORMS**

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.

- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.
- C. Refer to PART 4 for required reports.

#### 1.6 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of on site service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

#### 1.7 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven days notice to all trades and the Architect/Engineer prior to performing each test.

### PART 2 - PRODUCTS

NOT APPLICABLE

### PART 3 - EXECUTION

#### 3.1 GENERAL REQUIREMENTS

- A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.
- B. Recorded data shall represent actual measured or observed conditions.
- C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- D. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- F. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 23 09 00 for additional information.

- G. Installations with systems consisting of multiple components shall be balanced with all system components operating.

### 3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
  - 1. General Equipment Requirements:
    - a. Equipment is safe to operate and in normal condition.
    - b. Equipment with moving parts is properly lubricated.
    - c. Temperature control systems are complete and operable.
    - d. Proper thermal overload protection is in place for electrical equipment.
    - e. Direction of rotation of all fans and pumps is correct.
    - f. Access doors are closed and end caps are in place.
  - 2. Duct System Requirements:
    - a. All filters are clean and in place. If required, install temporary media.
    - b. Duct systems are clean and free of debris.
    - c. Fire/smoke and manual volume dampers are in place, functional and open.
    - d. Air outlets are installed and connected.
    - e. Duct system leakage has been minimized.
  - 3. Pipe System Requirements:
    - a. Coil fins have been cleaned and combed.
    - b. Hydronic systems have been cleaned, filled, and vented.
    - c. Strainer screens are clean and in place.
    - d. Shutoff, throttling and balancing valves are open.
- B. Report any defects or deficiencies to Architect/Engineer.
- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

### 3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

### 3.4 INSTALLATION TOLERANCES

- A.  $\pm 10\%$  of scheduled values:
  - 1. Adjust air inlets and outlets to  $\pm 10\%$  of scheduled values.
  - 2. Adjust piping systems to  $\pm 10\%$  of design values.

- B. Adjust supply, return, and exhaust air-handling systems to +10% / -5% of scheduled values.

### 3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one damper or valve must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.
- D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.

### 3.6 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.

## PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

### 4.1 VERIFICATION OF EXISTING SYSTEMS

- A. Perform a pre-balance of systems serving the area of construction prior to the start of any other work. Do not make adjustments to the systems. If the systems are not operating at maximum capacity, temporarily drive system to maximum and take readings for the system. Return the system to its original state when measurements are complete.
  - 1. Air Handling Unit (RTU-2, 4, 5, 6, 7A, 7B)
    - a. General Requirements:
      - 1) Existing Equipment Tag (if available).
      - 2) Location.
      - 3) Manufacturer, model, arrangement, class, discharge.
      - 4) Fan RPM.
    - b. Flow Rate:
      - 1) Supply flow rate (cfm)
      - 2) Return flow rate (cfm)
      - 3) Outside flow rate (cfm)
      - 4) Exhaust flow rate (cfm)
    - c. Pressure Drop and Pressure:
      - 1) Filter pressure drop.
      - 2) Total static pressure. (Indicate if across fan or external to unit).
      - 3) Inlet pressure.
      - 4) Discharge pressure.
- B. Report findings to Architect/Engineer on standard forms. Provide four (4) copies of report.



## 4.2 GENERAL REQUIREMENTS

### A. Title Page:

1. Project name.
2. Project location.
3. Project Architect.
4. Project Engineer (KJWW Engineering Consultants).
5. Project General Contractor.
6. TAB Company name, address, phone number.
7. TAB Supervisor's name and certification number.
8. TAB Supervisor's signature and date.
9. Report date.

### B. Report Index

### C. General Information:

1. Test conditions.
2. Nomenclature used throughout report.
3. Notable system characteristics/discrepancies from design.
4. Test standards followed.
5. Any deficiencies noted.
6. Quality assurance statement.

### D. Instrument List:

1. Instrument.
2. Manufacturer, model, and serial number.
3. Range.
4. Calibration date.

## 4.3 AIR SYSTEMS

### A. Air Moving Equipment:

1. General Requirements:
  - a. Drawing symbol.
  - b. Location.
  - c. Manufacturer, model, arrangement, class, discharge.
  - d. Fan RPM.
  - e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
  - f. Final frequency of motor at maximum flow rate (on fans driven by VFD).
2. Flow Rate:
  - a. Supply flow rate (cfm): specified and actual.
  - b. Return flow rate (cfm): specified and actual.
  - c. Outside flow rate (cfm): specified and actual.
  - d. Exhaust flow rate (cfm): specified and actual.
3. Pressure Drop and Pressure:
  - a. Filter pressure drop: specified and actual.
  - b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
  - c. Inlet pressure.
  - d. Discharge pressure.

- B. Fan Data:
1. Drawing symbol.
  2. Location.
  3. Manufacturer and model.
  4. Flow rate (cfm): specified and actual.
  5. Total static pressure: specified and actual. (Indicate measurement locations).
  6. Inlet pressure.
  7. Discharge pressure.
  8. Fan RPM.
- C. Electric Motors:
1. Drawing symbol of equipment served.
  2. Manufacturer, Model, Frame.
  3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
  4. Measured: Amps in each phase.
- D. Air Terminal (Inlet or Outlet):
1. Drawing symbol.
  2. Room number/location.
  3. Terminal type and size.
  4. Velocity: specified and actual.
  5. Flow rate (cfm): specified and actual.
  6. Percent of design flow rate.

#### 4.4 HEATING SYSTEMS

- A. Terminal Heat Transfer Units:
1. General Requirement:
    - a. Drawing symbol.
    - b. Location.
    - c. Manufacturer and model.
    - d. Include air data only for forced air units.
  2. Flow Rate:
    - a. Flow rate (cfm): specified and actual.
    - b. Water flow rate (gpm): specified and actual.
  3. Temperature:
    - a. Entering air temperature: specified and actual.
    - b. Leaving air temperature: specified and actual.
    - c. Entering water temperature: specified and actual.
    - d. Leaving water temperature: specified and actual.
  4. Energy:
    - a. Air Btuh (cfm x temperature rise x 1.09).
    - b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

**END OF SECTION 23 05 93**

## SECTION 23 07 13 - DUCTWORK INSULATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Insulation Jackets.

#### 1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer's certificate indicating qualifications.
- B. Materials: UL listed in Category HNKT; flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723.
- C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

#### 1.3 REFERENCES

- A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. ANSI/ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- C. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM E84 - Surface Burning Characteristics of Building Materials.
- E. ASTM E136 - Standard Test Method for the Behavior of Materials in a Vertical Tube Furnace at 750°C.
- F. ASTM E814 - Fire Tests of Through Penetrations Firestops.
- G. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.
- H. NFPA 255 - Surface Burning Characteristics of Building Materials.
- I. UL - XHEZ - Through Penetration Firestop Systems.
- J. UL 263 - Full Scale External Fire Tests with Hose Stream.
- K. UL 723 - Surface Burning Characteristics of Building Materials.
- L. UL 1479 - Fire Tests of Through Penetrations Firestops.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 maximum 'K' value at 75°F; foil scrim kraft facing, 1.0 lb./cu. ft. density.
- B. Type B: Semi-rigid Fiberglass Board Wrap - Outside Application; ANSI/ASTM C612, Class 1; 0.25 maximum 'K' value at 75°F; foil scrim kraft facing, 3 lb./cu. ft. density.
- C. Type C: Flexible Fiberglass Liner; ANSI/ASTM C1071; 0.28 maximum 'K' value at 75°F; 1.5 lb/cu ft minimum density; coated air side for 4000 fpm air velocity.
- D. Type E: Double wall ductwork insulation; fiberglass; 0.27 maximum 'K' value at 75°F mean temperature; 1.5 lb/cu ft density.
- E. Type G: Preformed rigid fiberglass acoustical liner. ANSI/ASTM C1071; 0.23 maximum 'K' value at 75°F mean temperature; Noise Reduction Coefficient (NRC) per ASTM C423 Type "A" mounting of 0.70 0.75 for 1" thickness, 0.90 for 1.5" thickness. Liner shall be factory coated with an anti-microbial agent to prevent fungus and bacteria growth per ASTM G-21 and G-22. Max flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723.

### 2.2 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

### 2.3 JACKET COVERINGS

- A. Aluminum Jackets: ASTM B209; 0.016" thick; smooth or embossed stucco finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Architect.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.
- B. Install materials after ductwork has been tested.
- C. Clean surfaces for adhesives.
- D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.
- E. Exterior Duct Wrap - Flexible, Type A:
  - 1. Apply with edges tightly butted.
  - 2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.

3. Seal joints with adhesive backed tape.
  4. Apply so insulation conforms uniformly and firmly to duct.
  5. Provide high-density insulation inserts at trapeze duct hangers and straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
  6. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
  7. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
  8. Staples may be used, but must be covered with tape.
  9. Vapor barrier must be continuous.
  10. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.
- F. Semi Rigid Fiberglass Board Wrap - Type B (Outdoor Use):
1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.
  2. Space pins as required to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
  3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of the same facing tape with adhesive.
  4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.
  5. Install vapor barrier jacket. Cover with aluminum jacket covering with seams on the bottom of horizontal ductwork.
  6. Seal all butt joints with metal draw bands screwed to jacket and filled with sealant. Seal all joints watertight.
  7. Provide positive slope on top of all horizontal surfaces to prevent ponding of water.
- G. Interior Insulation - Flexible Duct Liner, Type C:
1. Observation of Duct Lining:
    - a. After installation of ductwork, Architect/Engineer may select random observation points in each system.
      - 1) At each observation point, cut and remove an 18" x 18" section of ductwork and liner for verification of installation.

- 2) Random observation points based on one opening per 75 lineal ft. of total duct run.
  - b. When any of the observation points shows non-compliance, additional points will be designated by the Architect/Engineer, and observation repeated.
  - c. If 20% of points observed do not comply, remove and replace all lined ducts and repeat tests. Where replacement is not required, correct all non-compliances.
  - d. At end of observation, repair all duct lining and observation holes by installing standard, insulated, hinged access doors per Section 23 33 00.
  - e. Paint or finish to match adjacent duct surfaces.
2. Impale on spindle anchors welded or mechanically fastened to the duct. Adhesive or glue fastened anchors are not acceptable. Maximum anchor spacing per SMACNA Duct Construction Standards or manufacturer's recommendations, whichever is more restrictive. Locate pins less than 3" from corners and at intervals not over 6" around the perimeter at leading and trailing edges. Locate pins within 3" of transverse joints and at intervals not over 16" long the length of the duct. Pins must be long enough to prevent compressing the insulation.
  3. In addition to anchors, secure liner with UL listed adhesive covering over 90% of the duct surface.
  4. Install per the latest edition of the SMACNA Manual.
  5. Leading edges shall be covered as follows:
    - a. For duct velocities below 3000 fpm, coat leading edges with adhesive. Neatly butt liner without gaps at transverse joints. Cut liner flush with end of the duct section for tight joints with no exposed duct. If adhesive is shop installed, field apply additional adhesive to the end of each duct section for complete adhesion of the liner. Protect edges from dirt and debris.
    - b. For duct velocities above 3000 fpm, cover leading edges with metal nosing. Use nosing on upstream edges of each section of duct. If the duct can be installed in either direction, provide nosing on each end or clearly mark the duct to allow visual verification after installation. Verify duct velocities based on the scheduled air flow rates and determine where metal nosing is required.
    - c. Install metal nosing in the following locations (regardless of velocity):
      - 1) The first three fittings downstream of all fans.
      - 2) At all duct liner interruptions. This includes fire dampers, access doors, branch connections, and all other locations where the edge of the liner is exposed.
      - 3) Trailing edges of transverse joints do not require metal nosings.

6. Overlap liner at longitudinal joints. Make longitudinal joints at corners of the duct unless the duct size does not allow this. Coat longitudinal joints with adhesive at velocities over 2500 fpm.
  7. Seal all damaged duct liner with adhesive and glass cloth. Do not damage duct liner surface coatings.
  8. Duct dimensions given are net inside dimensions. Increase sheet metal to allow for insulation thickness.
- H. Double-Wall Ductwork Insulation – Type E:
1. Install insulation per manufacturer's recommendations.
  2. Duct dimensions given are net inside dimensions of inner wall.
- I. Performed Fiberglass Acoustical Liner, Rigid – Type G:
1. Cut and secure duct liner inside duct.
  2. Install insulation pins or adhesive in locations as recommended by the manufacturer.
  3. Seal all damaged duct liner and fill all gaps with manufacturer approved sealant. Do not damage duct liner surface coatings.
  4. Where edges show evidence of delamination, the damaged areas shall be secured by manufacturer approved sealant.
  5. Duct dimensions given are net inside dimensions. Increase sheet metal to allow for insulation thickness.
- J. Continue insulation with vapor barrier through penetrations unless code prohibits.
- K. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

### 3.2 SCHEDULE

- A. Refer to Section 23 31 00 for scheduling of insulation.

**END OF SECTION 23 07 13**





## SECTION 23 09 00 - CONTROLS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Complete System of Automatic Controls.
- B. Control Devices, Components, Wiring and Material.
- C. Instructions for Owners.
- D. Remodeling.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years' experience.
- B. TCC: Company specializing in the work of this section with minimum five years temperature control experience.
- C. Technician: Minimum five years' experience installing commercial temperature control systems.
- D. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

#### 1.3 REFERENCES

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/ASHRAE Standard 135-2001: BACnet<sup>®</sup> – A Data Communication Protocol for Building Automation and Control Networks, including all amendments.
- D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 volts Maximum).
- E. ANSI/NFPA 70 - National Electrical Code.
- F. ANSI/NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.
- G. ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality.
- H. ASHRAE 85 - Automatic Control Terminology for Heating, Ventilating, Air Conditioning.

#### 1.4 SUBMITTALS

- A. Equipment Coordination:
  - 1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
  - 2. Control valve selections shall be based on flow rates shown in approved shop drawings.

3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.
- B. Shop Drawings:
1. Submit shop drawings per Section 23 05 00. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
  2. Cross-reference **all** control components and point names in a single table located at the beginning of the submittal with the **identical** nomenclature used in this section.
  3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
  4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
  5. Diagrams shall include:
    - a. Wiring diagrams and layouts for each control panel showing all termination numbers.
    - b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
    - c. Identification of all control components connected to emergency power.
    - d. Schematic diagrams for all field sensors and controllers.
    - e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
    - f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
    - g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
    - h. All installation details and any other details required to demonstrate that the system will function properly.
    - i. All interface requirements with other systems.
  6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and

infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.

7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. **The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.**
8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.
9. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:
  - a. Valve Identification Tag.
  - b. Location.
  - c. Valve Type.
  - d. Valve Size.
  - e. Pipe Size.
  - f. Configuration.
  - g. Flow Characteristics.
  - h. Capacity.
  - i. Valve Cv.
  - j. Design Pressure Drop.
  - k. Pressure Drop at Design Flow.
  - l. Fail Position.
  - m. Close-off Pressure.
  - n. Valve and Actuator Model Number and Type.
10. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.
11. Provide PICS files indicating the BACnet® functionality and configuration of each device.

12. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements in the event that problems are found during BTL testing is required.
13. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.
14. Software: A list of operating system software, operator interface software, color graphic software, and third-party software.
15. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
16. Clearly identify work by others in the submittal.
17. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 23 05 00, submit an electronic copy of the O&M manuals in PDF format.
2. Provide three complete sets of manuals.
3. Each O&M manual shall include:
  - a. Table of contents with indexed tabs dividing information as outlined below.
  - b. Definitions: List of all abbreviations and technical terms with definitions.
  - c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
  - d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
  - e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
  - f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
  - g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.

- h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.
  - i. Original Software: Complete original issue CDs for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
  - j. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.
  - k. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project.
- D. Training Manual:
- 1. Provide a course outline and training manuals for each training class.
- E. Record Documents:
- 1. Submit record documentation per Section 23 05 00.
  - 2. Provide a complete set of “as-built” drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the “as-built” drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.
  - 3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
  - 4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.
  - 5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.

## 1.5 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.
- B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.6 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Control Valves.
- B. Flow Switches.
- C. Temperature Sensor Sockets.
- D. Gauge Taps.
- E. Automatic Dampers.
- F. Flow Meters.

1.7 AGENCY AND CODE APPROVALS

- A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.
  - 1. UL-916; Energy Management Systems.
  - 2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
  - 3. EMC Directive 89/336/EEC (European CE Mark).
  - 4. FCC, Part 15, Subpart J, Class A Computing Devices.

1.8 ACRONYMS

- A. Acronyms used in this specification are as follows:
  - 1. B-AAC BACnet Advanced Application Controller
  - 2. B-ASC BACnet Application Specific Controller
  - 3. BTL BACnet Testing Laboratories
  - 4. DDC Direct Digital Controls
  - 5. FMCS Facility Management and Control System
  - 6. GUI Graphic User Interface
  - 7. IBC Interoperable BACnet Controller
  - 8. IDC Interoperable Digital Controller
  - 9. LAN Local Area Network
  - 10. NAC Network Area Controller
  - 11. ODBC Open DataBase Connectivity
  - 12. OOT Object Oriented Technology
  - 13. OPC Open Connectivity via Open Standards
  - 14. PICS Product Interoperability Compliance Statement
  - 15. PMI Power Measurement Interface
  - 16. POT Portable Operator's Terminal
  - 17. TCC Temperature Control Contractor
  - 18. TCS Temperature Control System
  - 19. WAN Wide Area Network
  - 20. WBI Web Browser Interface

1.9 SUMMARY

- A. Provide new standalone FMCS for this project.

1.10 SYSTEM DESCRIPTION

- A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.

- B. The FMCS shall include Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.
- C. Provide materials and labor necessary to connect factory supplied control components.
- D. Provide central and remote hardware, software, and interconnecting wire and conduit.
- E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.
- F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.

#### 1.11 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job-specific configuration documentation, data files, configuration tools, and application-level software developed for the project. This shall include, but is not limited to, all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN/WAN/intranet and/or Internet connected routers and devices. Provide the Owner with all required IDs and passwords for access to any component or software program. The Owner shall determine which organizations shall be named in the SI organization ID ("**orgid**") of all software licenses. Owner shall be free to direct the modification of the "**orgid**" in any software license, regardless of supplier.

#### 1.12 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

#### 1.13 WARRANTY

- A. Refer to Section 23 05 00 for warranty requirements.
- B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.
- C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.
- D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

#### 1.14 WARRANTY ACCESS

- A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Delta Controls: Contact Steve McCloskey (630) 589-3804.

#### 2.2 SYSTEM ARCHITECTURE

- A. General:
  - 1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, a computer system, graphic user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.
  - 2. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.
- B. Open, Interoperable, Integrated Architectures:
  - 1. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data are not acceptable.
  - 2. The supplied system must be able to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs are not acceptable.
  - 3. Hierarchical or "flat" topologies are required to have system response times as indicated below and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network.
    - a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
    - b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

#### 2.3 NETWORKS

- A. The Local Area Network (LAN) shall be a 100 megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP. Provide support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.



- B. Local area network minimum physical and media access requirements:
  - 1. Ethernet; IEEE Standard 802.3.
  - 2. Cable; 100 Base-T, UTP-8 wire, Category 5.
  - 3. Minimum throughput; 100 Mbps.
- C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.
- D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.
- E. There shall be no power wiring in excess of 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

#### 2.4 NETWORK AREA CONTROLLER (NAC)

- A. The TCC shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.
- B. Each NAC shall provide the interface between the LAN or WAN and the field control devices and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:
  - 1. Calendar functions.
  - 2. Scheduling.
  - 3. Trending.
  - 4. Alarm monitoring and routing.
  - 5. Time synchronization.
  - 6. Integration of all controller data.
  - 7. Network Management functions.
- C. The Network Area Controller shall provide the following hardware features as a minimum:
  - 1. One Ethernet Port – 10/100 Mbps.
  - 2. One RS-232 port.
  - 3. One LonWorks Interface Port – 78KB FTT-10A (for LonWorks systems only).
  - 4. One RS-485 port.
  - 5. Battery backup.
  - 6. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
  - 7. The NAC must be capable of operation over a temperature range of 32°F to 122°F.
  - 8. The NAC must be capable of withstanding storage temperatures of between 0°F and 158°F.
  - 9. The NAC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.

- D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the NAC shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.
- E. The NAC shall support standard Web browser access via the Internet or an intranet and a minimum of five (5) simultaneous users.
- F. Event Alarm Notification and Actions:
  - 1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
  - 2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
  - 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
    - a. Alarm
    - b. Normal
  - 4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g. security, HVAC, Fire, etc.
  - 5. Provide timed (scheduled) routing of alarms by class, object, group, or node.
  - 6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- G. Treat control equipment and network failures as alarms and annunciated.
- H. Annunciate alarms in any of the following manners as defined by the user:
  - 1. Screen message text.
  - 2. E-mail of the complete alarm message to multiple recipients. Provide the ability to route and e-mail alarms based on:
    - a. Day of week.
    - b. Time of day.
    - c. Recipient.
  - 3. Pagers via paging services that initiate a page on receipt of e-mail message.
  - 4. Graphic with flashing alarm object(s).
  - 5. Printed message, routed directly to a dedicated alarm printer.
- I. The FMCS shall record the following for each alarm:
  - 1. Time and date.
  - 2. Location (building, floor, zone, office number, etc.).
  - 3. Equipment tag.
  - 4. Acknowledge time, date, and user who issued acknowledgement.
  - 5. Number of occurrences since last acknowledgement.

- J. Give defined users proper access to acknowledge any alarm.
- K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
- L. Provide a “query” feature to allow review of specific alarms by user-defined parameters.
- M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- N. An error log to record invalid property changes or commands shall be provided and available for review by the user.

## 2.5 BACNET FMCS

- A. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device’s compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).
- C. Interoperable BACnet Controller (IBC):
  - 1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB) and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals. Provide a PICS document showing the installed system’s compliance level to ANSI/ASHRAE Standard 135. Minimum compliance is Level 3.
  - 2. The IBCs shall be listed by the BACnet Testing Laboratory (BTL) as follows:
    - a. BACnet Building Controller(s) (B-BC).
    - b. BACnet Advanced Application Controller(s) (B-ACC).
    - c. BACnet Application Specific Controller(s) (B-ASC).
  - 3. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
  - 4. Each IBC sensor shall connect directly to the IBC and shall not use any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.

5. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require a 10% spare point capacity to be provided for all applications. Store all control sequences within or programmed into the IBC in non-volatile memory that does not depend on a battery to be retained.
6. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:
  - a. BACnet Device; MAC address, name, type and instance number.
  - b. BACnet Objects; name, type and instance number.
7. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each IBC.

D. Object Libraries

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the system supplier shall maintain an on-line accessible (over the Internet) library, available to all registered users, to provide new or updated objects and applications as they are developed.
4. All control objects shall conform to the control objects specified in the BACnet specification.
5. The library shall include applications or objects for the following functions, at a minimum:
  - a. Scheduling Object: The schedule must conform to the schedule object as defined in the BACnet specification, providing seven-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphic sliders to speed creation and selection of on-off events.
  - b. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphic "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
  - c. Override Object: Provide override object that is capable of restarting equipment turned off by other energy saving programs to maintain occupant comfort or for equipment protection.
  - d. Start-Stop Time Optimization Object: Provide a start-stop time optimization object to start equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupied time just

far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on historical performance.

- e. Demand Limiting Object: Provide a demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, gas, etc.). The object shall be able to monitor a demand value and predict (using a sliding window prediction algorithm) the demand at the end of the user-defined interval period (1 to 60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user-defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment setpoints to provide the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, display a message on the user's screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to provide both equipment protection and occupant comfort.

6. The library shall include control objects for the following functions:

- a. Analog Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
- b. Analog Output Object: Minimum requirement is to comply with the BACnet standard for data sharing.
- c. Binary Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment runtime by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
- d. Binary Output Object: Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as start-to-start delay must be provided. Incorporate the BACnet Command Prioritization priority scheme to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.
- e. PID Control Loop Object: Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable to allow proportional control only, or proportional with integral control, or proportional, integral and derivative control.

- f. Comparison Object: Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
  - g. Math Object: Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
  - h. Custom Programming Objects: Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including, but not limited to, math and logic functions and string manipulation. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for reuse.
  - i. Interlock Object: Provide an interlock object that provides a means of coordination of objects within a piece of equipment, such as an air handler or other similar types of equipment. An example is to link the return fan to the supply fan such that, when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming, thereby eliminating nuisance alarms during the off period.
  - j. Temperature Override Object: Provide an object whose purpose is to override a binary output to an "on" state in the event a user-specified high or low limit value is exceeded. Link this object to the desired binary output object as well as to an analog object for temperature monitoring to cause the override to be enabled. This object will execute a start command at the Temperature Override level of start/stop command priority, unless changed by the user.
  - k. Composite Object: Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphic shell of this container.
7. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). Provide the following as part of the standard library included with the programming software:
- a. LonMark/LonWorks Devices: These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. Support all network variables defined in the LonMark profile. The device manufacturer shall provide information (type

and function) regarding network variables not defined in the LonMark profile.

- b. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file, and documentation for the device to facilitate device integration.
- c. For BACnet devices, provide the following objects:
  - 1) Analog In.
  - 2) Analog Out.
  - 3) Analog Value.
  - 4) Binary.
  - 5) Binary In.
  - 6) Binary Out.
  - 7) Binary Value.
  - 8) Multi-State In.
  - 9) Multi-State Out.
  - 10) Multi-State Value.
  - 11) Schedule Export.
  - 12) Calendar Export.
  - 13) Trend Export.
  - 14) Device.
- d. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
- e. For BACnet devices, provide the following support at a minimum:
  - 1) Segmentation.
  - 2) Segmented Request.
  - 3) Segmented Response.
  - 4) Application Services.
  - 5) Read Property.
  - 6) Read Property Multiple.
  - 7) Write Property.
  - 8) Write Property Multiple.
  - 9) Confirmed Event Notification.
  - 10) Unconfirmed Event Notification.
  - 11) Acknowledge Alarm.
  - 12) Get Alarm Summary.
  - 13) Who-has.
  - 14) I-have.
  - 15) Who-is.
  - 16) I-am.
  - 17) Subscribe COV.
  - 18) Confirmed COV notification.
  - 19) Unconfirmed COV notification.
  - 20) Media Types.
  - 21) Ethernet.
  - 22) BACnet IP Annex J.
  - 23) MSTP.
  - 24) BACnet Broadcast Management Device (BBMD) function.
  - 25) Routing.

## 2.6 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

- A. The NAC shall be able to collect data for any property of any object and store resident in the NAC that shall have, at a minimum, the following configurable properties:
  - 1. Designating the log as interval or deviation.
  - 2. For interval logs, configure the object for time of day, day of week and the sample collection interval.
  - 3. For deviation logs, configure the object for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
  - 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
  - 5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- B. Store all log data in a relational database in the NAC that is accessible from a server (if the system is so configured) or a standard Web browser.
- C. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- D. All log data shall be available to the user in ALL the following data formats:
  - 1. HTML.
  - 2. XML.
  - 3. Plain text.
  - 4. Comma or tab separated values.
- E. The NAC shall archive its log data either locally (to itself) or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties:
  - 1. Archive on time of day.
  - 2. Archive on user-defined number of data stores in the log (buffer size).
  - 3. Archive when log has reached its user-defined capacity of data stores.
  - 4. Provide ability to clear logs once archived.

## 2.7 AUDIT LOG

- A. Provide and maintain an audit log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
  - 1. Time and date.
  - 2. User ID.
  - 3. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

## 2.8 DATABASE BACKUP AND STORAGE

- A. The NAC shall automatically backup its database on a user-defined time interval.



- B. Store copies of the current database and, at the most, the recently saved database in the NAC. The age of the most recently saved database shall depend on the user-defined database save interval.
- C. Store the NAC database in XML format to allow viewing and editing. Other formats are acceptable as long as XML format is supported.

## 2.9 GRAPHIC USER INTERFACE SOFTWARE

- A. Operating System:
  - 1. Provide computer with the most current Microsoft-based operating system with which the GUI has proven compatibility.
- B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu pulldowns and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line) that displays the location and the selected object identification.
- C. Point Organization: Organize points by equipment categories, location, or other means acceptable to Owner.
- D. Real-Time Displays: The GUI shall support the following graphic features and functions:
  - 1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file. Use of proprietary graphic file formats is not acceptable. In addition to, or in lieu of, a graphic background, the GUI shall support the use of scanned pictures.
  - 2. Graphic screens shall be able to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URLs, and links to other graphic screens.
  - 3. Graphics shall support layering, and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
  - 4. Modifying common application objects, such as schedules, calendars, and setpoints, shall be accomplished graphically.
    - a. Schedule times shall be adjusted using a graphic slider without requiring any keyboard entry from the operator.
    - b. Holidays shall be set by using a graphic calendar without requiring any keyboard entry from the operator.
  - 5. Commands to start and stop binary objects shall be made by selecting the object and the appropriate command from a pop-up menu. No text entry shall be required.
  - 6. Adjustments to analog objects, such as setpoints, shall be made by selecting the object and using a graphic slider to adjust the value. No text entry shall be required.

- E. System Configuration: At a minimum, the GUI shall include the necessary software and components to enable the operator to perform the following tasks with proper password access:
  - 1. Create, delete or modify control strategies.
  - 2. Add/delete objects.
  - 3. Tune control loops by adjusting control loop parameters.
  - 4. Enable or disable control strategies.
  - 5. Generate hard copy records or control strategies on a printer.
  - 6. Select alarm points and define the alarm state.
  - 7. Select points to be trended and initiate the recording of values automatically.
  - 8. View any trend as a graph.
  
- F. On-Line Help: Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
  
- G. Security: Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall be able to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operator's access for viewing and/or changing each system application, full screen editor, and object. Each operator shall be automatically logged off the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. Store all system security data in an encrypted format.
  
- H. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. Annunciate the failure of any device to the operator.
  
- I. Alarm Console:
  - 1. The system shall have a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and to acknowledge the alarm.
  - 2. When the alarm console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator are not acceptable. The use of the alarm console can be enabled or disabled by the system administrator.

## 2.10 WEB BROWSER CLIENTS

- A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™, Firefox™, or Chrome. Systems requiring additional software to enable a standard Web browser to reside on the client machine, or manufacturer-specific browsers, are not acceptable.
  
- B. 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 Graphic User Interface. Systems that require different views or that require different means of interacting with objects, such as schedules or logs, are not permitted.

- C. The Web browser client shall provide:
1. User log-on identification and password shall be required. If an unauthorized user attempts access, display a blank web page. Implement security using Java authentication and encryption techniques to prevent unauthorized access.
  2. Graphic screens developed for the GUI shall be the same screens used for the Web browser client. The web browser interface shall support all animated graphic objects supported by the GUI.
  3. 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.
  4. Store all graphic screens in the Network Area Controller (NAC) without requiring any graphics storage on the client machine.
  5. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
  6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
    - a. Modify common application objects, such as schedules, calendars, and setpoints, graphically.
      - 1) Schedule times shall be adjustable using a graphic slider, without requiring any keyboard entry from the operator.
      - 2) Holidays shall be set using a graphic calendar, without requiring any keyboard entry from the operator.
    - b. Commands to start and stop binary objects shall be made by right-clicking the selected object and selecting the appropriate command from a pop-up menu. No text entry shall be required.
    - c. View logs and charts.
    - d. View and acknowledge alarms.
    - e. Setup and execute SQL queries on log and archive information
  7. The system shall be able to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just his/her 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.
  8. 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.

## 2.11 SYSTEM PROGRAMMING

- A. The GUI software shall perform system programming and graphic display engineering. Access to the GUI software shall be through password access as assigned by the system administrator.

- B. Provide a library of control, application, and graphic objects to enable creation of all applications and user interface screens. Applications shall be created by selecting the control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphic connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Provide all software tools or processes to create applications and user interface displays.
- C. Programming Methods
1. Provide the capability to copy objects from the supplied libraries or from a user-defined library to the user's application. Link objects with a graphic linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; e.g., internal, external, hardware, etc.
  2. Configuration of each object shall be done through the object's property sheet using fill-in-the-blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.
  3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
  4. All programming shall be done in real time. Systems requiring the uploading, editing, and downloading of database objects are not allowed.
  5. The system shall support object duplication in a customer's database. An application, once configured, can be copied and pasted for easy reuse and duplication. All links, other than to the hardware, shall be maintained during duplication.

## 2.12 DDE DEVICE INTEGRATION

- A. The NAC shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The NAC shall act as a DDE client to another software application that functions as a DDE server.
- B. Provide the required objects in the library included with the Graphic User Interface programming software to support the integration of these devices into the FMCS. Objects provided shall include, at a minimum:
1. DDE Generic AI Object.
  2. DDE Generic AO Object.
  3. DDE Generic BO Object.
  4. DDE Generic BI Object.

## 2.13 SOFTWARE

- A. IDC/IBCs shall operate totally standalone and independent of a central computer for all specified control applications.
- B. Software shall include a complete operating system (OS), communications handler, point processing, energy management application packages as specified herein, standard control algorithms and specific control sequences (IDC/IBC) and an Owner/user custom control calculation package complete with interpreter.
- C. OS software shall be PROM resident, operate in real time, provide prioritized task scheduling, control time programs, monitor and manage communications, and scan inputs and outputs.
- D. Each IDC/IBC panel shall include the following energy management routines:
  - 1. Time of day scheduling.
  - 2. Optimum start/stop.
  - 3. Peak demand limiting.
  - 4. Economizer control.
  - 5. PID control.
  - 6. Supply air reset.
  - 7. Outdoor air reset.
- E. Input/output point processing software shall include:
  - 1. Update of all connected input and output points at least once per second.
  - 2. Analog to digital conversion, scaling and offset, correction of sensor non-linearity, sensing no response or failed sensors, and conversion of values to 32-bit floating point format. Retain both the maximum and minimum values sensed for each analog input in memory. It shall be possible to input subsets of standard sensor ranges to the A/D converter and assign gains to match the full-scale 32-bit conversion to achieve high accuracy readout.
  - 3. A reasonability check on all analog inputs against previous values and discarding of values falling outside preprogrammed reasonability limits.
  - 4. Assignment of proper engineering units and status conditions to all inputs and outputs.
  - 5. Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and alarm) to an input or to assign a set of floating limits (alarm a reset schedule or FMCS control point) to the input. Assign each alarm a unique differential to prevent a point from oscillating in and out of alarm. Make alarm comparisons of each scan cycle.
  - 6. Adjustment of timing from two seconds to two minutes in one-second increments to eliminate nuisance alarms on startup.
- F. Command Control software shall manage the receipt of commands from the server and from control programs.
  - 1. Provide command delay to prevent simultaneous energizing of loads. Delay must be programmable from 0 to 30 seconds.

2. Assign each command a command and residual priority to manage conflicts created by multiple programs having access to the same command point. Allow only outputs with a higher command priority to execute. Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority.
  3. A "fixed mode" option (override) shall allow inputs to and outputs from control programs to set to a fixed state or value. When in the "fixed mode", assign inputs and outputs high residual command priority to prevent override by application programs.
- G. Alarm lockout software shall prevent nuisance alarms. On initial start-up of mechanical equipment, assign a "timed lockout" period to analog points to allow them to reach a stable condition before activating alarm comparison logic. Lockout period shall be programmable for each point from 0 to 90 minutes in one-minute increments.
- H. A "hard lockout" shall also be provided to positively lock out alarms when equipment is turned off or when a true alarm depends on the condition of an associated point. Hard lockout points and lockout initiators shall be operator programmable.
- I. Runtime shall be accumulated based on the status of a digital input point. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Runtime counts shall reside in non-volatile memory and have DCP resident runtime limits assignable through the operator's terminal.
- J. A transition counter shall count the number of times a device is cycled on or off. Counter shall be non-volatile and capable of counting 600,000 cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.
- K. Custom IDC/IBC programs shall meet the control strategies called for in the sequence of operation of these specifications. Each IDC/IBC shall have resident in its memory and available to the programs a full library of IDC/IBC algorithms, intrinsic control operators, arithmetic, logic, and relational operators. Provide the following features:
1. Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and Adaptive Control (self-learning). Use Adaptive Control where the controlled flow rate is variable (such as TAB units and variable flow pumping loops). The adaptive control algorithm shall monitor the loop response to output corrections and adjust the loop response characteristics in accordance with the time constant changes imposed by variable flow rates. The algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of the system dynamics so that, on system shutdown and restart, the learning process starts from where it left off. Standard PID algorithms are not acceptable substitutes for variable flow applications since they will provide satisfactory control at only one flow rate and will require continued manual fine tuning.
  2. All IDC/IBC setpoints, gains and time constants associated with IDC/IBC programs shall be available to the operator for display and modification via the operator workstation.
  3. The execution interval of each IDC/IBC loop shall be adjustable from 2 to 120 seconds in one-second increments.
  4. IDC/IBC control programs shall assign initialization values to all outputs so controlled devices assume a failsafe position on start-up.

- L. Provide time and event programming (TEP) capability to initiate a controlled sequence of events for execution at a specific time or upon the occurrence of an event. Minimum program features required are:
1. Analog points commandable to a specific value.
  2. Digital points commandable to a specific state; e.g. on or off; fast, slow or off.
  3. Initiator to be a specific day and time or a specific event; e.g. an alarm.
  4. Manual initiation via operator's command.
  5. Commands must honor command delays (to prevent current surges), and assigned minimum ON and OFF times.
  6. Commands must honor command and residual priority structures allowing higher priority commands (like smoke control) to override lower priority commands (like time of day scheduling) and residual priority.
  7. Ability to chain TEPs.
  8. Ability to enable and disable TEPs individually.
  9. Ability to enable/disable TEP initiators.
- M. Store Energy Management application programs and associated data files in non-volatile or 72-hour battery backed RAM memory. Individual programs shall be accessible from the operator workstation for enabling/disabling and program parameter modification and shall include:
1. Time Programs:
    - a. Provide an independent start and stop program time for each system identified in the points list.
    - b. It shall be possible to assign two independent start and stop times/days to any equipment connected to a controller.
  2. Exception Day Scheduling:
    - a. Provide an Exception Day program for holiday and other planned exceptions to time programs. Exception schedules shall be DSC resident and operator programmable up to one year in advance.
    - b. The program shall allow definition of up to 32 exception time spans. Define each span by calendar start day and calendar stop day.
  3. An IDC/IBC resident temporary scheduler shall allow operators to modify present time program control of equipment. Minimum feature set required is:
    - a. Ability to alter time schedules as much as six days in advance.
    - b. Ability to alter either start time, stop time or both for each day.
    - c. Temporary schedule shall be in effect for all days specified.

- d. Automatically delete the temporary schedule and restore program to normal schedule after execution.
  - e. Ability to assign schedule changes as permanent as well as temporary.
- N. The IDC/IBC shall have built-in, non-descriptive, self-test procedure for checking the indication lights, digital display, and memory. It shall display advisories for maintenance, performance, and/or software problems.
- O. All electronics shall be:
  - 1. Standard locally stocked modular boards.
  - 2. Plug-in type.
  - 3. Furnish all ROM programs unlocked.

## 2.14 VALVE ACTUATORS

- A. General:
  - 1. Actuators shall be sized to operate the valve through its full range of motion and shall close against pump shutoff pressure without producing audible noise at any valve position.
  - 2. Provide visual position indication.
  - 3. Mount actuator directly on valve or provide linear motion assembly as required for valve type.
- B. Valve Actuators - Electronic:
  - 1. Actuator shall be UL listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation, and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
  - 2. Actuators shall be rated for 60,000 full stroke cycles at rated torque. Stall motor not acceptable.
  - 3. Tri-state/floating actuators shall have auto-zeroing function for realigning valve position.
  - 4. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
  - 5. Spring return actuators shall have an internal spring return mechanism. Non-mechanical forms of fail-safe operation are not acceptable.
  - 6. Provide analog feedback signal for positive position indication as required by control diagrams.



## 2.15 CONTROL INSTRUMENTATION

### A. Temperature Sensors:

#### 1. Room Temperature Sensor:

- a. Sensor Only: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range,  $\pm 0.50^\circ\text{F}$  accuracy, no setpoint adjustment or override button.
- b. Sensor with Setpoint Adjustment: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range,  $\pm 0.50^\circ\text{F}$  accuracy, with exposed single setpoint adjustment (no numeric temperature scale – provide with a single warmer/cooler or red/blue visual scale), no override button.

#### 2. Duct Temperature Sensor:

- a. Thermistor or RTD type. Pneumatic transmitters with transducers are not acceptable.

### B. Humidity Measuring Devices:

#### 1. Humidity Sensors:

- a. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be  $\pm 5\%$  of reading.

## 2.16 CONDUIT

- A. Conduit and Fittings: Refer to Electrical Section 26 05 33 for materials and sizing.

## 2.17 WIRE AND CABLE

- A. Wire and Cable Materials: Refer to Electrical Section 26 05 13 for wire and cable materials.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

- A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.
- B. Install system and materials in accordance with manufacturer's instructions.
- C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.
- D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.

- E. Verify locations of wall-mounted devices (such as thermostats) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed 48".
- F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.
- G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.
- H. After completion of installation, test and adjust control equipment.
- I. Check calibration of instruments. Recalibrate or replace.
- J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.
- K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall not be powered from the life safety branch of the emergency power system. Coordinate emergency power source connections with the Architect/Engineer.
- L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.
- M. Remodeling:
  - 1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. In the event that wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.
- N. Labels For Control Devices:
  - 1. Provide labels indicating service of all control devices in panels and other locations.
  - 2. Labels may be made with permanent marking pen in the control panels if clearly legible.
  - 3. Use engraved labels for items outside panel such as outside air thermostats.
  - 4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.

### 3.2 GRAPHIC DISPLAY

- A. Create a customized graphic for each piece of equipment indicated on the itemized points list.
- B. Components shall be arranged on graphic as installed in the field.
- C. Include each graphic point listed in the itemized points list using real time data.
- D. Provide a graphic representation of the following:
  - 1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
  - 2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.
  - 3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area's AHU.
  - 4. Show the location of each thermostat on the floor plan.
  - 5. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
- E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:
  - 1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
  - 2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
  - 3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, and boilers, as a minimum.
  - 4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:
  - 1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
  - 2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
  - 3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

### 3.3 CONDUIT INSTALLATION

- A. Conduit Sizing and Installation: Refer to Electrical Section 26 05 33 for execution and installation.
  - 1. Thermostats/temperature sensors shall be installed in junction boxes, flush with the wall, and shall be coordinated for orientation with Architect/Engineer.

### 3.4 WIRE AND CABLE INSTALLATION

- A. Wire and Cable Materials Installation: Refer to Electrical Section 26 05 13 for execution and installation.
- B. Field Quality Control:
  - 1. Inspect wire and cable for physical damage and proper connection.
  - 2. Torque test conductor connections and terminations to manufacturer's recommended values.
  - 3. Perform continuity test on all conductors.
  - 4. Protection of cable from foreign materials:
    - a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
    - b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.
- C. Installation Schedule:
  - 1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations

in hazardous areas, as defined in the National Electrical Code, shall be connected using flexible conduit rated for the environment.

### 3.5 FMCS INSTALLATION

- A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.
- B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

### 3.6 COMMISSIONING

- A. Upon completion of the installation, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and debugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.
- B. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation.
- C. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25% spare capacity for future expansion.
- D. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- E. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

### 3.7 PREPARATION FOR BALANCING

- A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).
- B. Check the calibration and setpoints of all controllers.
- C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
- D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum cfm.

- E. Verify the operation of all interlock systems.

### 3.8 TEST AND BALANCE COORDINATION

- A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
- B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.
- C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.
- D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

### 3.9 DEMONSTRATION AND ACCEPTANCE

- A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

### 3.10 TRAINING

- A. On-Site:
  - 1. After completion of commissioning, the manufacturer shall provide 16 hours of training on consecutive days for 4 Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

### 3.11 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- F. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.

**END OF SECTION 23 09 00**

## SECTION 23 11 23 - NATURAL GAS PIPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Natural Gas Piping System.

#### 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

#### 1.3 REFERENCES

- A. ANSI/AWS D1.1 - Structural Welding Code.
- B. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
- C. ASME - Boiler and Pressure Vessel Code - Section 9.
- D. ASME B1.20.1 - Pipe Threads, General Purpose.
- E. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- F. ASME B16.5 - Pipe Flanges and Flanged Fittings.
- G. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.
- H. ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
- I. ASME B16.39 - Malleable Iron Threaded Pipe Unions.
- J. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
- K. ASME B18.2.2 - Square and Hex Nuts, Inch Series.
- L. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- M. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
- N. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.
- O. ASTM A197 - Standard Specification for Cupola Malleable Iron.
- P. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

- Q. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- R. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- T. NFPA 54 - National Fuel Gas Code.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

#### 1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 23 05 00 for the required natural gas piping system electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

### PART 2 - PRODUCTS

#### 2.1 NATURAL GAS (0 TO 125 PSI)

- A. Design Pressure: 125 psi.  
Maximum Design Temperature: 350°F
- B. Piping - 2" and Under:
  - 1. Pipe: Standard weight steel, threaded and coupled, ASTM A53.
  - 2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)
  - 3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.
  - 4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.
- C. Piping - 2-1/2" and Over:
  - 1. Pipe: Standard weight black steel, beveled ends, ASTM A53.
  - 2. Joints: Butt welded and flanged.
  - 3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.
  - 4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5.



- D. Shutoff Valves/Throttling Valves:
  - 1. BA-13: 2" and under, threaded 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, bronze body and chrome plated brass ball, Teflon seats and packing. Apollo #80-100, Nibco #T580-70-UL or #T585-70-UL, Watts #B-6000.
  - 2. PL-2: 2-1/2" thru 4", 125# steam @ 450°F, 175# CWP @ 180°F, flanged, cast iron body, full port. Walworth #1700F, DeZurik #425, F-RS49.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Connect to all equipment with flanges or unions.
- D. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for treatment.

### 3.2 TESTING PIPING

- A. Low Pressure - Up to 1 psi:
  - 1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.
- B. High Pressure - Above 1 psi:
  - 1. Test piping with compressed air at twice the operating gas pressure, but at least 20 psi. System must hold this pressure without adding air for two hours.
- C. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

### 3.3 CLEANING PIPING

- A. Assembly:
  - 1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
  - 2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
  - 3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.

4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

### 3.4 INSTALLATION

- A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
- B. Install piping to conserve building space, and not interfere with other work.
- C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.
- G. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.
- H. Provide clearance for access to valves and fittings.
- I. Provide access doors where valves are not exposed.
- J. Prepare pipe, fittings, supports, and accessories for finish painting.
- K. Install valves with stems upright or horizontal, not inverted.
- L. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
- M. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.
- N. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
- O. Provide flanges or unions at all final connections to equipment, traps and valves.
- P. Gas piping shall not be used as a grounding conductor or electrode.
- Q. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

### 3.5 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. **All fittings shall be long radius type**, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Cut all pipe to exact measurement and install without springing or forcing.
- H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

### 3.6 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.
- B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.
- C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

### 3.7 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.
- C. Use of forged weld-on fittings is also limited as follows:
  - 1. Must have at least same pressure rating as the main.
  - 2. Header or main must be 2-1/2" or over.
  - 3. Branch line is at least two pipe sizes under header or main size.

- D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

### 3.8 JOINING OF PIPE

#### A. Threaded Joints:

- 1. Ream pipe ends and remove all burrs and chips.
- 2. Protect plated pipe and valve bodies from wrench marks when making up joints.
- 3. Apply Teflon tape to male threads.

#### B. Flanged Joints:

- 1. Steel flanges shall be raised face.
- 2. Bolting for services up to 500°F shall be ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 "Square and Hex Bolts" and B18.2.2 "Square and Hex Nuts".
- 3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
- 4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
  - a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
  - b. Maximum pressure rating of at least 250 psig.
  - c. Minimum temperature rating: -10°F.
  - d. Maximum temperature rating of at least 170°F for water systems operating 140°F and less.

#### C. Welded Joints:

- 1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
- 2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
- 3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
- 4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

5. Backing rings shall be used for all butt weld joints 3" size and over, and for all sizes where operating pressure is over 200 psig and/or temperature is over 400°F. Backing rings shall be of the material being welded.

**END OF SECTION 23 11 23**



## SECTION 23 22 00 - STEAM AND STEAM CONDENSATE PIPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Steam Piping System.
- D. Steam Condensate Piping System.

#### 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials and Procedures: Conform to ANSI/ASME SEC 9.

#### 1.3 REFERENCES

- A. ANSI/ASME SEC 9 - Welding and Brazing Qualifications.
- B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- C. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
- D. ANSI/ASME B16.9 - Factory Made Wrought Steel Butt Welding Fittings.
- E. ANSI/ASME B31.1 - Code for Power Piping.
- F. ANSI/ASME B31.9 - Building Services Piping.
- G. ANSI/AWS D1.1 - Structural Welding Code.
- H. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- I. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- J. ASTM E90-02 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
- K. ASTM E413-87 - Classification for Rating Sound Insulation.

#### 1.4 SUBMITTALS

- A. Submit product data under provisions of Section 23 05 00. Include data on pipe fittings, valves and accessories.
- B. Include certification of compliance with ANSI/AWS D1.1 for all welders.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent corrosion and entrance of foreign matter.
- B. Deliver and store valves in shipping containers with labeling in place.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME B31.9 for systems operated at less than 125 psig, and ANSI/ASME B31.1 for systems operated at 125 psig and above.

## 1.7 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 23 05 00 for required steam and steam condensate piping systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

## PART 2 - PRODUCTS

### 2.1 STEAM PIPING (0 TO 125 psig)

- A. Design Pressure: 125 psig.  
Maximum Design Temperature: 353°F.
- B. Piping - 2" and Under:
  - 1. Pipe: Standard weight black steel, threaded and coupled, ASTM A53.
  - 2. Joints: Screwed.
  - 3. Fittings: 125 psi S - 175 psi. WOG, cast iron, ASTM A126, ANSI B16.4.
  - 4. Unions: 250 psi S - 500 psi. WOG, black malleable iron, ground joint with brass seat.
- C. Piping - 2-1/2" and Over:
  - 1. Pipe: Standard weight black steel, beveled ends, ASTM A53.
  - 2. Joints: Butt welded or flanged.
  - 3. Fittings: Standard weight seamless steel, butt welded type, ASTM A234, Grade WPB, ANSI B16.9.
  - 4. Flanges: 150 lb. forged steel, welding neck or slip-on, ASTM A181, Grade I, ANSI B16.5.
- D. Shutoff Valves:
  - 1. Ball Valves:
    - a. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

#### NOTES:

- 1) Provide extended shaft for all valves in insulated piping.



- 2) Provide lock out trim for all valves opening to atmosphere installed in steam and condensate piping. Solid extended shaft is not required on valves with lock out trim.

## 2.2 CONDENSATE PIPING (0 TO 125 psig)

- A. Design Pressure: 125 psig.  
Maximum Design Temperature: 353°F.
- B. Piping - 2" and Under:
  1. Pipe: Extra strong black steel, threaded and coupled, ASTM A53.
  2. Joints: Screwed.
  3. Fittings: 125 psi S - 175 psi WOG, black cast iron, ASTM A126, ANSI B16.4.
  4. Unions: 250 psi S - 500 psi WOG, black malleable iron, ground joint with brass seat.
- C. Shutoff Valves:
  1. Ball Valves:
    - a. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.

### NOTES:

- 1) Provide extended shaft for all valves in insulated piping.
- 2) Provide lock out trim for all valves opening to atmosphere installed in steam condensate piping. Solid extended shaft is not required on valves with lock out trim.

## 2.3 STRAINERS

- A. Unless otherwise indicated, strainers shall have stainless steel screens with perforations as follows:

Description	Steam All Sizes	Condensate All Sizes
Strainer	1/32"	3/64"

- B. Furnish pipe nipple with gate valve and threaded cap to blow down all strainer screens.
- C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.

- B. Remove scale and dirt on inside and outside before assembly.
- C. Make connections to equipment with flanges or unions.
- D. After completion, fill, clean, and treat systems.

### 3.2 TESTING PIPING

#### A. Steam Piping: Condensate Piping:

1. Complete all testing of pipes underground, or in chases and walls, before piping is concealed.
2. Complete all testing before insulation is applied, or if insulation is applied before the pipe is tested and a leak develops which ruins the insulation, the pipe installing contractor shall arrange and pay for replacing the damaged insulation.
3. Test piping with water at 150% of the maximum operating pressure.
4. Hold pressure for at least two hours.
5. Test to be witnessed by the Architect/Engineer or their representative, if requested by the Architect/Engineer.

### 3.3 CLEANING PIPING

#### A. Assembly:

1. Prior to assembly of pipe and piping components, all loose dirt, scale, oil and other foreign matter on internal or external surfaces shall be removed by means consistent with good piping practice subject to the approval of the Architect/Engineer's representative. Chips and burrs from machinery or thread cutting operation shall be blown out of pipe before assembly. Cutting oil shall be wiped from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external pipe joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative prior to starting any post erection cleaning operation in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative regarding specific procedures and scheduling. Arrange for proper disposal of cleaning and flushing fluids.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and install all strainer screens.

#### B. Water Flush:

1. Flush pipe and components with clean water until all discharge from system is clean. Maintain minimum velocities at all points of 5 ft/sec. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of pipes, ends of headers and as otherwise needed to flush entire system. After flushing, drain and/or blow out any residual water.

2. Water flush applies to the following systems:
  - a. Steam Piping
  - b. Condensate Piping
3. Steam and condensate pipes may be cleaned using compressed air at 80 to 90 psig. Maintain adequate airflow to obtain velocities of 5 feet per second.
4. Clean and replace all strainers after pipe cleaning.

### 3.4 INSTALLATION

#### A. General Installation Requirements:

1. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
2. Install piping to conserve building space and not interfere with use of space, other work, or equipment.
3. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
4. Slope steam piping 0.25" in 10 feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.
5. Slope steam condensate piping 0.5" in 10 feet. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply zinc rich primer to welds.

#### B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

#### C. Valves/Fittings and Accessories:

1. Provide clearance for installation of insulation and access to valves and fittings.
2. Provide access doors where valves and fittings are not exposed.
3. Provide drip trap assembly at low points and before control valves and pressure reducing valves.
4. Provide loop vents over trapped sections.
5. Prepare pipe, fittings, supports, and accessories for finish painting.
6. Provide drip legs as shown on the drawings, at low points, traps, and the base of all risers in steam, and condensate pipes. Unless otherwise shown, drip legs shall be full pipe size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, with a reducer and a 3/4" shutoff valve.
7. Install valves with stems upright or horizontal, not inverted.

8. Provide shutoff valves in supply and return to all equipment.
9. Install strainers in steam piping with the "wye" of the strainer to the side of the pipe in the horizontal plane to avoid pooling of condensate.

### 3.5 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied identification sufficient to determine conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of system. Use plugs, caps, blind flanges or other items designed for this purpose.
- E. Run pipe straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and to provide needed flexibility in piping.
- F. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise noted.
- G. Provide flanges or unions at all connections to equipment traps and valves to facilitate dismantling.
- H. Arrange piping and connections so equipment served may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.
- I. Use full and double lengths of pipe wherever possible.
- J. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size made only at control valve, pump, or trap.
- K. Cut all pipe to exact measurement and install without springing or forcing.
- L. Avoid creating, even temporarily, undue loads, forces or strains on valves, equipment or building elements with piping connections or supports.
- M. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for steam pipes, and from top, bottom or side for liquids.

### 3.6 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise indicated.

- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Branch connections from mains may be cut into black steel pipe using forged weld-on fittings:
  - 1. Steam.
  - 2. Condensate.
- D. Use of forged weld-on fittings is further limited as follows:
  - 1. Must have at least same pressure rating as the main.
  - 2. Header or main must be 2-1/2" or over.
  - 3. Branch pipe is at least two sizes under main size.

### 3.7 JOINING OF PIPE

- A. Threaded Joints:
  - 1. Screw threads shall conform to ANSI B2.1 "Pipe Threads".
  - 2. Ream pipe ends and remove all burrs and chips formed in cutting and threading.
  - 3. Protect plated pipe and valve bodies from wrench marks.
  - 4. Apply high temperature, anti-seize thread lubricant to male threads.
- B. Flanged Joints:
  - 1. Steel flanges shall conform to ANSI B16.5 "Steel Pipe Flanges and Flanged Fittings". Cast iron flanges shall conform to ANSI B16.1 "Cast Iron Flanged and Flanged Fittings". Steel flanges shall be raised face except when bolted to flat face cast iron flange.
  - 2. Bolting for services up to 399°F shall be ASTM A307, Grade B bolts and heavy hexagonal nuts. Bolting for services from 400°F to 790°F shall be ASTM A193, Grade B-7 with Grade 24 hexagonal nuts. Bolts and nuts shall conform to ANSI B18.2.1 "Square and Hex Bolts" or B18.2.2 "Square and Hex Nuts".
  - 3. Set flange bolts beyond finger tightness with an indicating torque wrench to insure equal tension in all bolts. Tighten bolts so those directly opposite are torqued in sequence.
  - 4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
    - a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
    - b. Gaskets used in piping systems for saturated steam service shall be approved by manufacturer for use in saturated steam applications up to and including 150 psig.
    - c. Gaskets used for superheated steam applications and for saturated steam systems with operating pressures greater than 150 psig saturated steam shall be of the spiral wound "chevron" metallic type with flexible graphite filler by the following manufacturers: Flexitallic (LS Style CG),

TEADIT (Style 913), Garlock (Flexseal Style RW), Lamons (SpiraSeal Style WR), Leader (Style LG-13).

- d. Gaskets used for steam condensate service including, but not limited to, condensate return, boiler feedwater, and condensate transfer piping systems shall meet the following requirements:
  - 1) Maximum pressure rating of at least 2,000 psig.
  - 2) Maximum continuous temperature rating of at least 650°F.

C. Welded Joints:

- 1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
- 2. Furnish to the Owner's Representative prior to start of work certificates qualifying each welder.
- 3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
- 4. Ends of pipe and fittings to be joined by butt welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.
- 5. Backing rings shall be used for all butt weld joints 3" size and over and for all sizes where operating pressure is over 200 psig and/or temperature is over 400°F. Backing rings shall be of the material being welded.

**END OF SECTION 23 22 00**

## SECTION 23 22 18 - STEAM AND STEAM CONDENSATE SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Steam Traps.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. Traps: Remanufactured traps are not acceptable.

#### 1.3 REFERENCES

- A. ANSI/ASTM - Boilers and Pressure Vessels Code.
- B. ANSI/NFPA 70 - National Electrical Code.
- C. ASTM A105 - Forgings, Carbon Steel, for Piping Components.
- D. ASTM A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

#### 1.4 SUBMITTALS

- A. Submit product data under provisions of Section 23 05 00. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
- B. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.
- C. Submit manufacturer's installation instructions.
- D. Submit operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 STEAM TRAPS

- A. Type T-3: Float and thermostatic type, 125 psig rated, cast iron body; balanced pressure thermostatic air vent; stainless steel valve seat, float, brass valve mechanism, and side inlet and outlet.

Acceptable Products (0-125 psig):

Armstrong Machine Works  
Hoffman Industrial Specialties Co.  
Spirax/Sarco Co., Inc.  
Clark-Reliance

Type A  
Series H, C, or X  
Type FT  
Type FT

## 2.2 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in steam condensate piping.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND APPLICATION

#### A. General Installation Requirements:

1. Install specialties in accordance with manufacturer's instructions.
2. Size traps to handle minimum of two and one-half times maximum condensate load of apparatus served, unless noted otherwise.
3. All traps shall be minimum 3/4" size.
4. Install traps with unions or flanges at both ends.
5. Provide shutoff valve and strainer at inlet, and check valve and shutoff valve at discharge of traps.
6. Provide minimum 10" long dirt pocket of same size as apparatus return connection between apparatus and trap.
7. Remove thermostatic elements from traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

**END OF SECTION 23 22 18**



## SECTION 23 31 00 - DUCTWORK

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Galvanized Ductwork
- B. Ductwork Reinforcement
- C. Ductwork Sealants
- D. Rectangular Ductwork - Single Wall
- E. Round Ductwork - Single Wall
- F. Rectangular Ductwork – Double Wall
- G. Exposed Ductwork (Rectangular, Round, or Oval)
- H. Flexible Duct
- I. Leakage Testing
- J. Ductwork Penetrations

#### 1.2 REFERENCES: Conform to all applicable requirements of the following publications:

- A. ADC Flexible Duct Performance and Installation Standards, 3<sup>rd</sup> Edition 1996.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASHRAE - Handbook 2012 Systems and Equipment; Chapter 19 - Duct Construction.
- D. ASHRAE - Handbook 2013 Fundamentals; Chapter 21 - Duct Design.
- E. ASTM A90 - Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- F. ASTM A167- Stainless & Heat-Resisting Chromium-Nickel Steel Plate, Sheet, & Strip.
- G. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- H. ASTM A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- I. ASTM E90-02 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
- J. ASTM E413-87 - Classification for Rating Sound Insulation.
- K. AWS D9.1M/D9.1 - Sheet Metal Welding Code.
- L. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
- M. NFPA 90B - Installation of Warm Air Heating and Air- Conditioning Systems.
- N. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Equipment.
- O. SMACNA – Air Duct Leakage Test Manual – 1985 Edition.
- P. SMACNA - HVAC Duct Construction Standards - 2005 Edition.

- Q. SMACNA - Round Industrial Duct Construction Standards - 1999 Edition.
- R. UL 181 - Factory-Made Air Ducts and Air Connectors.
- S. UL 181A - Closure Systems for Use With Rigid Air Ducts and Air Connectors
- T. UL 181B - Closure Systems for Use With Flexible Air Ducts and Air Connectors.

### 1.3 DEFINITIONS

- A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
- B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.

### 1.4 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 23 05 00 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.
- B. Duct drawings shall be at 1/4" minimum scale complete with the following information:
  - 1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
  - 2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
  - 3. Location and size of all duct access doors.
  - 4. Room names and numbers, ceiling types, and ceiling heights.
  - 5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
- C. KJWW will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver attached at the end of this specification section. KJWW will not consider blatant reproductions of original file copies an acceptable alternative to coordination drawings. Architectural plans will need to be obtained from the Architect.

## PART 2 - PRODUCTS

### 2.1 GALVANIZED DUCTWORK

- A. General Requirements:
  - 1. Duct and reinforcement materials shall conform to ASTM A653 and A924.
  - 2. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.

3. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
4. Ductwork reinforcement shall be of galvanized steel.
5. Ductwork supports shall be of galvanized or painted steel. Slip cable hangers are acceptable. Acceptable manufacturers are Gripple, Ductmate, Duro Dyne, or Architect/Engineer approved.
6. All fasteners shall be galvanized or cadmium plated.

## 2.2 DUCTWORK REINFORCEMENT

### A. General Requirements:

1. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
  - a. Ducts must be over 18" wide.
  - b. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
  - c. Tie rods must not exceed 1/2" diameter.
  - d. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

## 2.3 DUCTWORK SEALANTS

- A. One part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M.

## 2.4 RECTANGULAR DUCT - SINGLE WALL

### A. General Requirements:

1. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
2. Transitions shall not exceed the angles in Figure 4-7.

### B. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:

1. All ducts shall be cross-broken or beaded.
2. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:

- a. Type 1:
    - 1) **Description:** Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
    - 2) **Usage:** Limited to 3,000 fpm and vane lengths 36" and under.
  - b. Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.
  - c. Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.
  - d. Omitting every other vane is prohibited.
3. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. **Mitered elbows (with or without turning vanes) may not be substituted for radius elbows.** Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.
  4. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
  5. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.
  6. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.
  7. All lined duct shall utilize dovetail joints where round or conical taps occur. The dovetail joints shall extend past the liner before being folded over.
  8. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.
  9. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
    - a. Apply sealant to all inside corners. Holes at corners are not acceptable.
    - b. Acceptable Manufacturers: Ductmate Industries - 25/35/45, Nexus, Mez, or WDCI. Other manufacturers must submit test data and fabrication

standards and receive Architect/Engineer's approval before any fabrication begins.

10. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
  - a. Apply sealant to all inside corners. Holes at corners are not acceptable.
  - b. Flanges shall be 24-gauge minimum (not 26 gauge).
  - c. Acceptable Manufacturers: Lockformer TDC, TDF, United McGill, or Sheet Metal Connectors. Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

## 2.5 ROUND DUCTWORK - SINGLE WALL

- A. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
- B. Snap lock seams are not permitted.
- C. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
- D. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
- E. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
- F. Ductwork shall be suitable for velocities up to 5,000 fpm.
- G. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
- H. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
- I. Transverse Joint Connections:
  1. Crimped joints are not permitted.
  2. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
  3. Ducts and fittings larger than 36" shall have flanged connections.

4. Secure all joints with at least 3 sheet metal screws before sealing.
5. Slide-on flanges as manufactured by Ductmate Industries, Accuflange, or Sheet Metal Connectors are acceptable. Self-sealing duct systems are also acceptable (Lindab, Ward "Keating Coupling").

## 2.6 RECTANGULAR DUCT – DOUBLE WALL

- A. All applicable portions of Rectangular Duct – Single Wall shall apply.
- B. Furnish and install double-wall insulated airtight duct as shown on the drawings.
- C. Duct Construction:
  1. Galvanized steel exterior wall with solid galvanized steel interior wall.
  2. Rectangular double wall duct shall be suitable for pressures listed in the ductwork application schedule.
  3. All ductwork gauges and reinforcement shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space-consuming reinforcement.
  4. Ducts shall be 2-1/2" thick and completely metal enclosed with annular space completely filled with 1-1/2# density glass fiber insulation. Insulation shall have flame spread/smoke developed ratings of less than 25/50 per ASTM E84, NFPA 255, or UL 723.
  5. Divided flow fittings may be separate fittings or factory installed taps with the following construction requirements:
    - a. Airtight, continuous welds at intersection of fitting body and tap.
    - b. Tap liner spot welded to inner liner with weld spacing not over 3"80 mm.
    - c. Insulation packed around the tap area for complete cavity filling.
    - d. Carefully fit branch connections to cut-out openings in inner liner without spaces for air erosion of insulation or sharp projections for noise and airflow disturbance.
  6. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
  7. Support inner liner of ducts and fittings with metal spacers welded to maintain spacing and concentricity.
  8. Formed-on flanged transverse joint systems are acceptable provided that they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
    - a. Apply sealant to all inside corners. Holes at corners are not acceptable.
    - b. Flanges shall be 24-gauge minimum (not 26 gauge).

- c. Acceptable Manufacturers: Lockformer TDC, TDF, United McGill, or Sheet Metal Connectors. Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

## 2.7 FLEXIBLE DUCT

- A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.
- B. Flame Spread/Smoke Developed: Not over 25/50.
- C. Flexible duct shall have corrosion-resistant wire helix, bonded to an inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh.
- D. Inner liner shall be airtight and suitable for 6" WC static pressure through 10" diameter and shall be airtight and suitable for 4" WC static pressure 12" through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft<sup>2</sup>\*°F\*hr/Btuh. Temperature range of at least 0-180°F. Maximum velocity of 4,000 fpm.
- E. Usage:
  - 1. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
  - 2. Connections to air inlets and outlets. Do not exceed 6'-0" in length.
- F. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.
- G. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Provide openings in ducts for thermometers and controllers.
- B. Locate ducts with space around equipment for normal operation and maintenance.
- C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms
- D. During construction provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.

- E. Repair all duct insulation and liner tears.
- F. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
- G. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.
- H. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.
- I. Install all exterior ductwork per SMACNA Fig. 6-3. Where drawings do not indicate otherwise, ductwork seams and joints shall be sealed watertight and pitched to shed water.
- J. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible.
- K. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.

### 3.2 DUCTWORK APPLICATION SCHEDULE

USAGE	MATERIAL	PRESSURE CLASS	SEAL CLASS †	INSULATION (Refer to Section 23 07 13 for insulation types)
Exterior Supply Duct – Double Wall	Galvanized Sheet Metal 9round or rectangular	+3"	A	2-1/2" thick Type E
Fan to Outlet (Existing RTU)	Galvanized Sheet Metal - Rectangular	+2"	A	1-1/2" thick Type A
Fan to Outlet	Galvanized Sheet Metal - Round	+2"	A	1-1/2" thick Type A
Return Duct	Galvanized Sheet Metal	-2"	A	1" thick Type C
Exterior Return Duct	Galvanized Sheet Metal	-2"	A	2" thick Type B
General Exhaust Duct	Galvanized Sheet Metal	-1"	A	None or 1" thick Type C
Transfer Ducts	Galvanized Sheet Metal	-1/2"	---	1" thick Type C
Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.)	---	---	---	1-1/2" thick Type A



USAGE	MATERIAL	PRESSURE CLASS	SEAL CLASS †	INSULATION (Refer to Section 23 07 13 for insulation types)
† Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual				

### 3.3 DUCTWORK SEALING

#### A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

- #### B. For Seal Class A ducts, all transverse joints, longitudinal seams, and duct wall penetrations shall be sealed. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

### 3.4 TESTING

#### A. Duct - 2" WG or Less (positive or negative):

1. Systems shall not leak more than shown in Table 4-1 of SMACNA HVAC Air Duct Leakage Test Manual for Seal Class A.
2. Leak testing of these systems is not normally required for interior ductwork. However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
3. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
4. Seal ducts to bring the air leakage into compliance.
5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

- #### B. Test procedure shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:

1. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.

2. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
3. All joints shall be felt by hand, and all discernible leaks shall be sealed.
4. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
5. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.
6. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
7. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
8. The required leakage class for Seal Class A, both round and rectangular ducts, shall be 4.
9. Positive pressure leakage testing is acceptable for negative pressure ductwork.

### 3.5 DUCTWORK PENETRATIONS

- A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.
- B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.
- C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms.

**END OF SECTION 23 31 00**



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## **SECTION 23 33 00 - DUCTWORK ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Manual Volume Dampers.

#### **1.2 REFERENCES**

- A. ASTM E477-06a - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- B. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
- C. SMACNA - HVAC Duct Construction Standards – Third Edition - 2005.

### **PART 2 - PRODUCTS**

#### **2.1 MANUAL VOLUME DAMPERS**

- A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.
- E. Provide locking quadrant regulators on single and multi-blade dampers.
- F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
- G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General Installation Requirements:
  - 1. Install accessories in accordance with manufacturer's instructions.
  - 2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
  - 3. Coordinate and install access doors provided by others.

4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
- B. Manual Volume Damper:
1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.
  2. Provide ceiling access doors for manual volume dampers. When manual volume dampers are located above an inaccessible ceiling and an access door cannot be installed, provide a remote controlled volume control device for operation of the damper. Coordinate location with the Architect/Engineer.

**END OF SECTION 23 33 00**

## **SECTION 23 34 23 - POWER VENTILATORS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Roof Exhaust Fans.
- B. Rooftop Fan Curbs.
- C. Wall Exhausters.

#### **1.2 QUALITY ASSURANCE**

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.

#### **1.3 REFERENCES**

- A. AMCA 99 - Standards Handbook.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- D. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
- E. SMACNA - HVAC Duct Construction Standards, 1995 Edition.

#### **1.4 SUBMITTALS**

- A. Submit shop drawings per Section 23 05 00. Include product data on wall and roof exhausters, and ceiling and cabinet fans.
- B. Provide multi-rpm fan curves with specified operating point clearly plotted.
- C. Submit manufacturer's installation instructions.

#### **1.5 EXTRA STOCK**

- A. Provide one (1) extra belt set for each fan unit.

### **PART 2 - PRODUCTS**

#### **2.1 ROOFTOP EXHAUST FAN - BELT DRIVEN**

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.

- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.
- E. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.
- F. Motor mounted outside of air stream and ventilated with outside air. Motor not less than 1/3 HP.
- G. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- H. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- I. Furnish normally closed, electric motorized damper. Provide step down transformer if required. Install and wire damper to open when fan runs.
- J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods.
- K. Mill aluminum finish.
- L. Permanently lubricated, permanently sealed, self-aligning ball bearings.
- M. Acceptable Manufacturers: Aerovent, Greenheck, Cook, Carnes, Penn, ACME, or ILG.

## 2.2 ROOFTOP EXHAUST FAN - DIRECT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.
- E. Direct drive, motor mounted outside of air stream and ventilated with outside air.
- F. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- G. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- H. Furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.
- I. Furnish normally closed, electric motorized damper. Provide step-down transformer if required. Install and wire damper to open when fan runs.
- J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods.
- K. Mill aluminum finish.
- L. Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.



- M. Acceptable Manufacturers: Aerovent "FACX", Cook "ACE-D", Greenheck, ILG – CRD, ACME PX, Penn DX, Carnes, Twin City DCRU.

### 2.3 WALL EXHAUST FAN - BELT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.
- E. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.
- F. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- G. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- H. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods.
- I. Mill aluminum finish.
- J. Acceptable Manufacturers: ACME, Carnes, Cook, Greenheck, or Penn.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated lag screws to roof curb.
- C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.
- D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

**END OF SECTION 23 34 23**



## **SECTION 23 37 00 - AIR INLETS AND OUTLETS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Grilles And Registers.
- B. Architectural Square Panel Diffusers.

#### **1.2 QUALITY ASSURANCE**

- A. Test and rate performance of air inlets and outlets per ASHRAE 70.
- B. Test and rate performance of louvers per AMCA 500L-99.
- C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

#### **1.3 REFERENCES**

- A. ANSI/ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Inlets and Outlets.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.
- D. SMACNA - Duct Construction Standards.

#### **1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 23 05 00.
- B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.
- C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.
- D. Submit manufacturer's installation instructions.

#### **1.5 REGULATORY REQUIREMENTS**

- A. Conform to ANSI/NFPA 90A.
- B. Conform to ASHRAE 90.1.

### **PART 2 - PRODUCTS**

#### **2.1 GRILLES AND REGISTERS**

- A. Reference to a grille means an air supply, exhaust or transfer device without a damper.

- B. Reference to a register means an air supply, exhaust or transfer device with a damper.
- C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.
- D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- E. The capacity and size of the unit shall be as shown on the drawings.
- F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to  $10^{-12}$  watts with a 10 dB room effect. Noise in classrooms may not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002 and ASHRAE 70.
- G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.
- H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.
- I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.
- J. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.
- K. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.
- L. Acceptable Manufacturers: Tuttle & Bailey, Titus, Price, Nailor, Carnes, Metalaire, Krueger.

## 2.2 ARCHITECTURAL SQUARE PANEL DIFFUSERS

- A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.
- B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.
- C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- D. The capacity and size of the unit shall be as shown on the drawings.
- E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to  $10^{-12}$  watts with a 10 dB room effect. Noise in classrooms may not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002 and ASHRAE 70.
- F. Diffusers shall be architectural solid square panel and flush with ceiling.

- G. The exposed surface shall be smooth, flat and free of visible fasteners. The face panel shall be 22 gauge steel with a rolled edge or shall be 18 gauge with a smooth ground, uniform edge.
- H. The back pan shall be one piece 22 gauge stamped and shall include an integral inlet. (Welded inlets and corner joints are not acceptable).
- I. Diffusers with a 24x24 back pan shall have a minimum 18x18 face panel size. Diffusers with a 12x12 back pan shall have a minimum 9x9 face panel size.
- J. The face panel shall be mechanically fastened to the back panel with steel components. (Plastic fasteners are not acceptable.)
- K. Acceptable Manufacturers: Tuttle & Bailey, Titus, Price, Nailor, Carnes, Metalaire, Krueger.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General Installation Requirements:
  - 1. Install items in accordance with manufacturers' instructions.
  - 2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
  - 3. Install diffusers to ductwork with air tight connections.
  - 4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
- B. Volume Damper:
  - 1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

**END OF SECTION 23 37 00**



## SECTION 23 74 1 - PACKAGED ROOFTOP AIR CONDITIONING UNITS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Packaged Rooftop Dehumidifier Unit.
- B. Unit Controls.
- C. Remote Panel.
- D. Roof Mounting Frame and Base.

#### 1.2 QUALITY ASSURANCE

- A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).
- B. All units must be UL or ETL listed and must contain UL labeled components.
- C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.
- D. Conform to ASHRAE 90.1.
- E. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

#### 1.3 REFERENCES

- A. AHRI 210 - Unitary Air Conditioning Equipment.
- B. AHRI 240 - Air Source Unitary Heat Pump Equipment.
- C. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.
- D. ASHRAE 37 - Methods of Testing for Rating Unitary Air Conditioning and Heat Pump Equipment.
- E. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings except Low-Rise Residential Buildings.
- F. NFPA 70 - National Electrical Code.
- G. NFPA 90A - Installation of Air Conditioning and Ventilating System.
- H. UL - Underwriters' Laboratory.
- I. USGBC - Leadership in Energy and Environmental Design (LEED) Rating System.

#### 1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00.
- B. Indicate electrical service and duct connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

1.7 WARRANTY

- A. Provide five (5) year manufacturer's warranty for compressors.
- B. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

1.8 MAINTENANCE SERVICE

- A. Furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.
- B. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibrations.
- C. Submit copy of service call work order or report, and include description of work performed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Desert Aire

2.2 MANUFACTURED UNITS

- A. Provide roof-mounted units having electric refrigeration and hot gas reheat.
- B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, controls, air filters, refrigerant cooling coil and compressor.
- C. There should be a remote outdoor condenser. The installing contractor is responsible for piping and wiring to the remote condenser from the unit.
- D. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

2.3 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners. Access doors or removable panels shall be provided at each



section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 18 gauge.

- B. Outside Air Intakes: The unit shall include an integral outdoor air intake assembly. The outside air shall be introduced after the evaporator coil and before the condensing coil.
  - 1. This shall include a two position damper and actuator.
  - 2. This shall include an outdoor rain hood and bird screen with aluminum cleanable filters.
- C. Insulation: Minimum of ¾" thick engineered polymer closed-cell foam insulation. Protect edges from erosion.
- D. Air Filters: Four inch pleated filter in disposable media in metal frames.
- E. Roof Mounting Curb: Minimum 24" Vibrocurb.

#### 2.4 FANS/MOTORS

- A. Supply Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor sheave, and rubber isolated hinge mounted motor. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
- B. Belt drive fans must be within  $\pm 10\%$  of scheduled RPM.
- C. All fans must be statically and dynamically balanced.
- D. Belt drive fans shall have slide rails, adjusting screws, anchor bolts, and bedplates.
- E. Motors shall be open drip-proof with grease lubricated bearings.
- F. Drives shall be V-belt type with adjustable pitch sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
- G. No equipment shall be selected or operate above 90% of its motor nameplate rating.
- H. Motor shall have 1.15 service factor.

#### 2.5 REFRIGERATION SYSTEM

- A. Refrigerant: The system's operating refrigerant shall be R-407C.
- B. Timed Defrost Cycle: The unit shall include a defrost cycle activated by suction pressure to automatically defrost the evaporator coil for low temperature operation.
- C. Receiver: The unit shall include a refrigerant receiver. The receiver shall assist the unit in operating at the highest efficiency over a wide range of load conditions.
- D. Evaporator dehumidifier coil:
  - 1. Provide copper tube with aluminum copper fin coil assembly.

2. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in at least two directions towards the outlet, with a slope of at least 1/8" foot.
3. Evaporator Bypass: Provide a two-position evaporator damper due to the introduction of outside air.

## 2.6 COMPRESSOR

- A. Provide heavy-duty, scroll, hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier. The compressor shall be external vibration isolated.
- B. Five minute timed off circuit shall delay compressor start.
- C. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.
- D. Refrigerant type and quantities shall meet the ozone depletion and global climate change limits of LEED credit EAc4, Enhanced Refrigerant Management (follow the latest edition at the time of bidding or as referenced in these specifications).

## 2.7 REFRIGERANT CONDENSER COILS

- A. Air-Cooled Condenser (Reheat Coil)
  1. Fins shall be die-formed aluminum and shall be damage resistant. Fin spacing shall be 12 FPI, maximum.
  2. Tubes shall be fabricated from seamless drawn copper. The tubes shall be mechanically expanded into the fins to form a permanent metal-to-metal bond for the maximum heat transfer and stability. The coil shall be a minimum of two rows deep.
- B. Remote Air-Cooled Condenser:
  1. The size and capacity shall be shown as on the schedule. The systems shall be able to reject all the recovered heat (THR) to the outdoor condenser.
  2. The unit shall have a weatherproof electrical panel.
  3. The cabinet shall be heavy gauge aluminum and the side shall be one piece construction.
  4. Provide copper tube aluminum fin coil assembly with sub-cooling rows.
  5. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor.

## 2.8 ELECTRICAL

- A. The electrical control panel shall be easily accessible. It shall be of adequate size to house all the electrical controls and devices. The unit shall be provided with single point

power to serve the controls, fan, and compressor. There shall be a 24V transformer to power the electrical controls.

## 2.9 DDC TEMPERATURE CONTROLS

- A. A digital controller will be used to control the dehumidification system.
- B. The system will include temperature and humidity sensors to be field installed in the return air duct or space.
- C. Install standalone control module providing communication between unit controls and DDC temperature control system. Control module shall be compatible with temperature control system specified in Section.

## 2.10 PERFORMANCE

- A. See the schedule.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.
- B. Verify that proper power supply is available.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting frame level.
- C. All field wiring shall be in accordance with the National Electrical Code.
- D. P-traps must be provided for all drain pans.
- E. Comb all coils to repair bent fins.
- F. Install on vibration isolation as scheduled on drawings.

### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide initial start-up and shutdown during first year of operation, including routine servicing and check-out.

**END OF SECTION 23 74 11**



## **SECTION 23 81 21 - COMPUTER ROOM AIR CONDITIONING UNITS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Package Computer Room Air Conditioning Ceiling Mounted Units.

#### **1.2 REFERENCES**

- A. ANSI NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ANSI/ASME - Boilers and Pressure Vessels Code.
- E. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. ASHRAE 52 - Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- G. FS TT-C-490 - Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings.
- H. UL - Underwriters' Laboratories.

#### **1.3 SUBMITTALS**

- A. Submit shop drawings under provisions of Section 23 05 00.
- B. Indicate water, drain, electrical and refrigeration rough-in connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.

#### **1.4 REGULATORY REQUIREMENTS**

- A. Conform to ANSI/NFPA 90A for the installation of computer room air conditioning units.
- B. Conform to ASHRAE 90.1.

#### **1.5 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

#### **1.6 WARRANTY**

- A. Provide five (5) year manufacturer's warranty on all compressors.

## PART 2 - PRODUCTS

### 2.1 COMPUTER ROOM AIR CONDITIONING CEILING MOUNTED UNITS

#### A. Acceptable Manufacturers:

1. Liebert, Mini-Mate Series.
2. Stulz Air Technology Systems (SATS)
3. Data-Aire
4. Canatal

#### B. Manufactured Units:

1. Provide packaged, air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fans, filters, humidifier, remote condensing unit, and controls.
2. Assemble unit for ceiling installation with service access required.
3. Unit shall be concealed above the ceiling with return and supply air duct flanges.
4. Performance shall be as scheduled on the drawings.

#### C. Evaporator Cabinet and Frame:

1. Cabinet and Chassis: Heavy gauge galvanized steel or 16 gauge aluminum.
2. Access Panels: Galvanized steel or 16 gauge aluminum with Gaskets.
3. Insulation: Thermally and acoustically line cabinet interior with one inchthick acoustic duct liner or 1/2" thick 6 lbs/cu.ft. density foam insulation.
4. Duct Connections: Provide return and supply ductwork flanges.

#### D. Evaporator Fans and Motors:

1. Fans: Double inlet, forward curved, direct drive centrifugal fans or plenum fan, statically and dynamically balanced, on steel shaft with self-aligning permanently lubricated bearings.
2. Motor: Permanent split capacitor, high efficiency single speed with internal overload protection.

#### E. Evaporator Coils (Direct Expansion):

1. Direct expansion cooling coil of seamless copper tubes expanded into aluminum fins.
2. Single refrigeration circuit with externally equalized expansion valve with hot gas bypass.
3. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions,

considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.

F. Electrical Panel:

1. Service Connections, Wiring, and Disconnect Requirements: Conform to the National Electrical Code.
2. Disconnect Switch: Non-automatic molded NEMA-3R or NEMA-12 case circuit breaker or non-fused disconnect with lockable handle.

G. Control System:

1. Microprocessor based with wall mounted control enclosure with LCD display and membrane keypad for user interface.
2. Wall mounted control shall display unit status, allow setpoint adjustment, and show alarm conditions.
3. Controls shall allow for:
  - a. Restart after power loss.
  - b. Maintain room temperature and relative humidity setpoints by activation of refrigeration or heating coils, or both.
  - c. Provide internal seven day clock function for set back temperatures.
  - d. User LCD shall provide indication of on/off, fan speed, operating mode (cooling, heating, dehumidifying), current day/time, and temperature/relative humidity.
  - e. System shall monitor and alarm with audible and visual signal high temperature, low temperature, and high humidity. Silence switch shall be available to shut off audible alarm.
4. Provide relay BACNet connection of key alarm conditions to building DDC system. Refer to Section 23 09 00 for additional information.

H. Air Cooled Condensing Unit (Remote Mounted):

1. Hermetic or scroll refrigerant compressors with resilient suspension system, oil strainer, sight glass/moisture indicator, internal motor protection, high pressure switch, and crankcase heater.
2. Corrosion resistant cabinet with copper tube aluminum fin coils, direct drive propeller fan with permanently lubricated ball bearings, single phase motors with internal overload protection.
3. Corrosion resistant cabinet with copper tube aluminum fin coils, direct drive propeller fan with permanently lubricated ball bearings, single phase motors with internal overload protection.
4. Provide pre-charged refrigerant line sets and accessories of sizes needed for installation. Verify lengths of piping required for installation.
5. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

6. Refrigerant type and quantities shall meet the ozone depletion and global climate change limits of LEED credit EAc4, Enhanced Refrigerant Management (follow the latest edition at the time of bidding or as referenced in these specifications).
- I. Condensate Pump:
    1. Packaged unit matched to evaporator unit including float switch, pump, motor assembly, check valve, and reservoir.
    2. Provide alarm to indicate high level reservoir.
    3. Unit shall be powered from evaporator unit with appropriate field connections available.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that proper power supply is available.

#### 3.2 INSTALLATION

##### A. General Installation Requirements:

1. Install units in accordance with manufacturer's instructions.
2. Coordinate installation of computer room air conditioning units with computer room raised floor installer.
3. Flush all piping before making final connections to units.
4. Comb all coils to repair bent fins.
5. Factory authorized service agent who will assist in commissioning the unit shall inspect installation prior to start-up. Submit start-up report with O&M manuals.

##### B. Condensate Removal:

1. Provide adequate drainage connections for water cooled units, condensate system.
2. Install condensate pump if required to remove condensate. Discharge to nearest code approved receptor or to a properly vented indirect waste fitting.

**END OF SECTION 23 81 21**



## **SECTION 23 82 00 - TERMINAL HEAT TRANSFER UNITS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Finned Tube Radiation.
- B. Cabinet Heaters.

#### **1.2 QUALITY ASSURANCE**

- A. All filters shall be UL listed Class 1 or Class 2.
- B. All electrical equipment shall have a UL label.
- C. All louvers and dampers shall have AMCA certified ratings.
- D. Factory wired equipment shall conform to ANSI/NFPA 70.

#### **1.3 REFERENCES**

- A. ANSI/ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
- B. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ANSI/NFPA 70 - National Electrical Code.

#### **1.4 SUBMITTALS**

- A. Submit shop drawings per Section 23 05 00.
- B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
- C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
- D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.
- E. Submit manufacturers' installation instructions.

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

- A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

#### **1.6 REGULATORY REQUIREMENTS**

- A. Conform to ASHRAE 90.1.

## 1.7 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

## PART 2 - PRODUCTS

### 2.1 FINNED TUBE RADIATION - PEDESTAL MOUNT

- A. Cabinets shall be minimum 16 gauge steel with baked enamel finish.
- B. Final color selection shall be by the Architect.
- C. Provide end caps, corner pieces, adjustable extensions, and other accessories required for proper appearance and service.
- D. Provide supports with matte black finish.
- E. Provide access doors at all valves if cabinet is not easily removable.
- F. All cabinet and accessories shall be securely connected with no exposed fasteners.
- G. Support 1/2" tubes on 36" centers and larger tubes on 48" centers.
- H. Elements shall be copper tube with aluminum fins.
- I. Cabinet size, element length and element size shall meet the scheduled capacities, but not be less than the sizes scheduled.
- J. Acceptable Products: Vulcan 'Lino-Vane', Sterling - 'PM', Rittling 'ETL'.

### 2.2 STEAM CABINET HEATERS

- A. Units shall include cabinet, fan, motor, coil, filter, inlet grille and discharge grille.
- B. Cabinets: 16 gauge exposed surfaces and 18 gauge concealed surfaces. Plastic exposed parts are not acceptable.
- C. Baked enamel finish. Color selected by Architect.
- D. All motors shall be three-speed permanent split capacitor with integral thermal overload protection.
- E. Coils shall have finned copper tubes.
- F. Provide 1" thick disposable filters or 1/2" thick washable 65% aluminum filters ahead of all coils.
- G. Provide a concealed unit mounted fan switch with "Off-High-Medium-Low" positions that doubles as disconnect.
- H. Acceptable Manufacturers: Trane - 'Force-Flo', Sterling, Modine, Rittling, Sigma, Vulcan, Airtherm.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General Installation Requirements:

1. Install all products per manufacturers' instructions.
2. Coordinate recess sizes for recessed equipment.
3. Protect units with protective covers during construction.
4. Comb all coils to repair bent fins.

#### B. Fin Tube:

1. Locate finned tube radiation as shown and run cover wall-to-wall, unless otherwise shown. Center elements under windows.

### 3.2 CLEANING

- A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.
- C. Install new filters.

**END OF SECTION 23 82 00**



## SECTION 26 05 00 - BASIC ELECTRICAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 27 05 28. This section is also applicable to Fire Alarm and Detection Systems Section 28 31 00.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in each specification section.

#### 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make his portion of the Electrical Work a finished and working system.
- C. Description of Systems shall be as follows:
  - 1. Extension of adjacent City Center Building electrical power system to and including light fixtures, equipment, motors, devices, etc.
  - 2. Extension of adjacent City Center Building grounding system.
  - 3. Extension of adjacent City Center Building fire alarm system.
  - 4. Modifications to existing lightning protection system.
  - 5. Wiring of equipment furnished by others.
  - 6. Removal work and/or relocation and reuse of existing systems and equipment.
  - 7. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.

#### 1.3 OWNER FURNISHED PRODUCTS

- A. The Owner will supply manufacturer's installation data for new equipment purchased by him for this project.
- B. This Contractor shall make all electrical system connections shown on the drawings or required for fully functional units.
- C. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

#### 1.4 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to

schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.

## 1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, AND CONTROL CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.

### B. Definitions:

1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

9. Low Voltage Technology Wiring: The wiring associated with the Technology Systems, used for analog or digital signals between equipment.
10. Telecommunications Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
  - a. Lighting Fixtures
  - b. Gravity flow piping, including steam and condensate.
  - c. Sheet metal.
  - d. Cable trays, including access space.
  - e. Other piping.
  - f. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

- E. Temperature Control Contractor's or Subcontractor's Responsibility:
1. Wiring of all devices needed to make the Temperature Control System functional.
  2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
  3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
- F. Electrical Contractor's Responsibility:
1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
  2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
  3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
  4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
  5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.
- G. General (Electrical/Technology):
1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
  2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.
  3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
  4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and



the Technology Contractor has convened to determine the exact location and requirements of the installation.

5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Technology Wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. KJWW will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by KJWW. KJWW will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.7 QUALITY ASSURANCE

### A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

### B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

### C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the Illinois Community College Board and Codes, Laws, Ordinances and other regulations having jurisdiction over this installation.
2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
3. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.

E. Examination of Drawings:

1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways so as to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better quality number shall govern.
8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.

9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

F. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit MEP 2014.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, fittings, etc.

1.8 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<b>Referenced Specification Section</b>	<b><u>Submittal Item</u></b>
26 05 73	Power System Study
26 09 33	Lighting Control System
26 22 00	Dry Type Transformers
26 24 16	Panelboards
26 28 16	Disconnect Switches

<b>Referenced Specification Section</b>	<b><u>Submittal Item</u></b>
26 28 21	Contactors
26 29 23	Variable Frequency Drives
26 41 00	Lightning Protection Equipment
26 43 00	Surge Protection Devices
26 51 00	Lighting
28 31 00	Fire Alarm and Detection Systems

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
  - a. Date
  - b. Project title and number
  - c. Contractor's name and address
  - d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
  - e. Description of items submitted and relevant specification number
  - f. Notations of deviations from the contract documents
  - g. Other pertinent data
  
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
  - a. Date
  - b. Project title and number
  - c. Architect/Engineer
  - d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses
  - f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
  - g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
  
3. Composition:
  - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
  
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances;

and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:
  - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**
6. Submittal Identification and Markings:
  - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.



8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 26 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 26 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

1.9 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

- C. Preparation:
  - 1. Itemize the cost for each of the following:
    - a. Overhead and profit.
    - b. Bonds.
    - c. Insurance.
    - d. General Requirements: Itemize all requirements.
  - 2. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
    - a. Contractor's own labor forces.
    - b. All subcontractors.
    - c. All major suppliers of products or equipment.
  - 3. Break down all costs into:
    - a. Material: Delivered cost of product with taxes paid.
    - b. Labor: Labor cost, excluding overhead and profit.
- D. Update Schedule of Values when:
  - 1. Indicated by Architect/Engineer.
  - 2. Change of subcontractor or supplier occurs.
  - 3. Change of product or equipment occurs.

#### 1.10 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

#### 1.11 PRODUCT DELIVERY, STORAGE, HANDLING AND MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- B. Keep all materials clean, dry and free from damaging environments.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

#### 1.12 WARRANTY

- A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.

- B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

#### 1.13 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

#### 1.14 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis of design and establishes the quality required.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fit in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on his part or on the part of other Contractors whose work is affected.
- E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

## PART 3 - EXECUTION

### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:
1. Placing fill over underground and underslab utilities.
  2. Covering exterior walls, interior partitions and chases.
  3. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation:
1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. All junction boxes are closed and identified in accordance with Section 26 05 53 Electrical Identification.
    - b. Light fixtures, including ceiling-mounted exit and emergency lights, are installed and operational.
    - c. Light fixture whips are suspended above the ceiling.
    - d. Conduit identification is installed in accordance with Section 26 05 53 Electrical Identification.
    - e. Light fixtures are suspended independently of the ceiling system when required by these contract documents.
    - f. All wall penetrations have been sealed.
  2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.3 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
  2. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
  3. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.
- C. The following must be submitted before Architect/Engineer recommends final payment:
  1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
  4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Architect/Engineer.
  5. Inspection and testing report by the fire alarm system manufacturer.
  6. Start-up reports on all equipment requiring a factory installation or start-up.

### 3.4 OPERATION AND MAINTENANCE MANUALS

- A. General:
  1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
  2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div23.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.

### 3.5 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The instructions shall include:
  1. Maintenance of equipment.
  2. Start-up procedures for all major equipment.
  3. Description of emergency system operation.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to the Owner's representative so his representative can be present if desired.
- F. Minimum hours of instruction time for specific items and/or systems shall be as indicated in each individual specification section. Allow minimum four hours for general instructions.
- G. Operating Instructions:
  1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.
  2. If the Contractor does not have staff that can adequately provide the required instructions, he shall include in his bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.6 RECORD DOCUMENTS

- A. The following paragraphs supplement the requirements of Division 1.

- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

### 3.7 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.
- C. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect his color preference before ordering.

### 3.8 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### 3.9 SPECIAL REQUIREMENTS

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.



- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.

### 3.10 SYSTEM COMMISSIONING

- A. The electrical systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.
- B. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.
  - 1. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.11 FIELD QUALITY CONTROL

- A. General:
  - 1. Conduct all tests required during and after construction.
  - 2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
  - 3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
  - 4. Any wiring device, electrical apparatus or lighting fixture, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
  - 5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than the National Electrical Code Standards. Take readings between conductors, and between conductors and ground.
  - 6. If the results obtained in the tests are not satisfactory make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.
- B. Other Equipment:
  - 1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections

properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.

- C. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.

**END OF SECTION 26 05 00**

## SECTION 26 05 03 - THROUGH PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

#### 1.3 REFERENCES

- A. UL 723 - Surface Burning Characteristics of Building Materials
- B. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- C. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- D. Warnock Hersey - Directory of Listed Products
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- F. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- G. 2006 International Building Code
- H. NFPA 5000 – Building Construction Safety Code

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings:
  - a. Floor penetrations located outside wall cavities.
  - b. Floor penetrations located outside fire-resistance-rated shaft enclosures.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.
- F. In accordance with LEED EQc4.1, Low-Emitting Materials - Adhesives and Sealants, all adhesives and sealants used on the interior of the building must comply with the following requirements:
  1. Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
  2. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

## 1.6 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
  1. Review foreseeable methods related to firestopping work.
  2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.7 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of

the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Produces Division.
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk.
4. Tremco; Sealant/Weatherproofing Division.
5. Johns-Manville.
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Wiremold/legrand: FlameStopper

## 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- G. Provide firestopping systems classified by UL or listed by Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:
  1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated  
 F Rating = Floor/Wall Rating  
 T Rating = Floor/Wall Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated  
 F Rating = Wall Rating  
 T Rating = 0

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated  
 F Rating = Wall/Floor Rating  
 T Rating (Floors) = Floor Rating

<u>Penetrating Item</u>	<u>UL System No.</u>
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.

- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

### 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### 3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### 3.4 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions

and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

**END OF SECTION 26 05 03**



## **SECTION 26 05 05 - ELECTRICAL DEMOLITION FOR REMODELING**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Electrical demolition

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS AND EQUIPMENT**

- A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.
- B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.
- C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.
- D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.
- E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.
- F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.
- G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

#### **3.2 PREPARATION**

- A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.

- B. Coordinate removal of utility service with Utility Company.
- C. 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. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.
- D. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.
- E. Existing Electrical Service:
  - 1. Contractor shall determine scheduling for removal of existing service.
  - 2. Maintain existing service to the adjacent Hotel Building while it is occupied.
- F. Existing Fire Alarm System: Maintain existing system in service while the adjacent Hotel Building is occupied. Disable system only to make switchovers and connections. Obtain permission from Owner before partially or completely disabling system. Minimize outage duration. Allow for outages to be performed after-hours.

### 3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.
- C. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.
- D. Disconnect and remove outlets and devices that are to be demolished.
  - 1. In public access areas where existing walls are not furred out (Atrium, Bar, Ballroom, etc.), remove outlet or devices' associated back box, supports, and conduit and conductors back to source. Patch opening created from removal of device to match surrounding finishes.
  - 2. In non-public access areas where existing walls are not furred out (Storage Rooms, Service Corridors, etc.). Remove conduit, supports, and conductors back to source. Devices' back box and conduit mounted in walls that are to remain can be abandoned in place. Provide appropriate cover plate for all abandoned back boxes, matching cover plate material specified on project material list.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories. Ballasts in light fixtures installed prior to 1980 shall be incinerated in EPA approved incinerator or disposed of in EPA certified containers and deposited in an EPA landfill certified for PCB disposal or recycled by permitted ballast recycler. Punctured or leaking ballasts must be disposed of according to Federal Regulations

under the Toxic Substance Control Act. Provide Owner and Architect/Engineer with a Certificate of Destruction to verify proper disposal.

- H. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.
- K. HID and fluorescent lamps, determined by the Toxicity Characteristic Leachate procedure (TCLP), to be hazardous waste shall be disposed of in an EPA-permitted hazardous waste disposal facility or by a permitted lamp recycler.
- L. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- M. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means. Where conduit is in concrete slab, cut conduit flush with floor, pull out conductors, and plug conduit ends.
- N. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

#### 3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or are to be reused.
- B. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

**END OF SECTION 26 05 05**



## SECTION 26 05 13 - WIRE AND CABLE

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Building wire
- B. Fire-rated cable
- C. Remote control and signal cable

#### 1.2 REFERENCES

- A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- B. UL 44 – Thermoset-Insulated Wires and Cables
- C. UL 83 – Thermoplastic-Insulated Wires and Cables
- D. UL 1581 – Standard for Electrical Wires, Cables, and Flexible Cords

### PART 2 - PRODUCTS

#### 2.1 BUILDING WIRE

- A. Feeders and Branch Circuits Larger than 6 AWG: Copper, stranded conductor, 600 volt insulation, THHN/THWN or XHHW-2.
- B. Feeders and Branch Circuits exposed on Rooftops: Copper stranded conductor, 600 volt insulation, XHHW-2.
- C. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600 volt insulation, THHN/THWN. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid or stranded conductor, unless otherwise noted on the drawings.
- D. Control Circuits: Copper, stranded conductor 600 volt insulation, THHN/THWN.
- E. Each 120 and 277 volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

#### 2.2 FIRE-RATED CABLE

- A. Two-hour Fire Rated Mineral Insulated Cables: Copper conductor, 600 volt insulation, rated 90°C, Type MI.

#### 2.3 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

- C. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

## PART 3 - EXECUTION

### 3.1 WIRE FOR SPECIALIZED SYSTEMS

- A. Wire for specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.

### 3.2 CONTRACTOR CHANGES

- A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16.
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.
- C. Record drawing shall include the calculations and sketches.

### 3.3 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use no wire smaller than 18 AWG for low voltage control wiring (<100 volts).
- C. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet.
- D. The ampacity of multiple conductors in one conduit shall be derated per National Electrical Code, Article 310. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.
- E. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.
- F. Splice only in junction or outlet boxes.
- G. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- H. Make conductor lengths for parallel circuits equal.
- I. All conductors shall be continuous in conduit from last outlet to their termination.
- J. Terminate all spare conductors on terminal blocks, and label the spare conductors.
- K. Cables or wires shall not be laid out on the ground before pulling.
- L. Cables or wires shall not be dragged over earth or paving.

- M. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- N. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- O. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

#### 3.4 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially thru raceway.
- D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.
- E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
- F. Only nylon rope shall be permitted to pull cables into conduit and ducts.
- G. Completely and thoroughly swab raceway system before installing conductors.
- H. Conductor Supports in Vertical Raceways:
  - 1. Support conductors in vertical raceways in accordance with NEC 300.19 and Table 300.19(A) Spacing of Conductors Supports.
  - 2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

#### 3.5 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Use suitable cable fittings and connectors.
- C. Run all open cable in a neat and symmetrical manner. Follow the routing as illustrated on the drawings as closely as possible. If routing is not illustrated then the Contractor shall choose his own routing, but in any case it shall be run in a manner previously stated.
- D. Open cable shall be supported by the appropriate size bridle rings or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same bridle rings.

- E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.
- F. Where open cables are grouped, they shall be neatly bundled and held together with nylon tie wraps placed every 2.5 ft. on the bundle. Where tie bundle passes through a bridle ring it shall be fastened to the ring with a tie wrap.
- G. Bridle ring supports shall be installed at a minimum of five foot (5') intervals. All rings shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc.
- H. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

### 3.6 FIRE-RATED CABLE INSTRUCTIONS

- A. Terminations of the fire-rated cable must be outside of the fire zone.
- B. Fire-rated cable shall be installed according to the manufacturer's recommendations.

### 3.7 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for copper conductor terminations, 8 AWG and larger.
- C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use copper, compression connectors applied with circumferential crimp for copper wire splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:
  - 1. Facing the front and operating side of the equipment, the phase identification shall be:
    - a. Left to Right - A-B-C
    - b. Top to Bottom - A-B-C



- J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

### 3.8 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Building Wire and Power Cable Testing: Test shall be made by means of an insulation testing device such as a "Megger" using not less than 500 volts D.C. test potential.
- C. Inspect wire and cable for physical damage and proper connection.
- D. Torque test conductor connections and terminations to manufacturer's recommended values.
- E. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.
- F. Provide documentation of the manufacturer's recommended lug torque value for copper conductors, the date the lugs were torqued, and installed torque readings. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.
- G. Protection of wire and cable from foreign materials:
  - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
- H. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

**END OF SECTION 26 05 13**



## SECTION 26 05 26 - GROUNDING AND BONDING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Equipment grounding system
- B. Bonding system
- C. Grounding electrode system

#### 1.2 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. Comply with UL 467 Grounding and Bonding Equipment.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

#### 1.3 SUMMARY

- A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

### PART 2 - PRODUCTS

#### 2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 26 05 13 "Wire and Cable".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Copper Bonding Conductors: As follows:
  - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
  - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
  - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

G. **[GB]:** Grounding Bus:

1. Copper bar, 1/4" x 2" x 12". Provide with wall mounting brackets, insulators and pre-tapped holes. Mount in screw cover box labeled "Ground".
2. Approved Manufacturers: Harger GBI Series, Erico B544 Series.

2.2 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Hydraulic compression type or exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.

PART 3 - EXECUTION

3.1 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  2. Make connections with clean, bare metal at points of contact.
  3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to

grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

- F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
- G. Tighten screws and bolts for grounding and bonding 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.
- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.2 INSTALLATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then use a bolted clamp. Bond straps directly to the basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- D. In raceways, use insulated equipment grounding conductors.

### 3.3 EQUIPMENT GROUNDING SYSTEM

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.
- C. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

### 3.4 BONDING SYSTEM

- A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.
- B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.

- C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.
- D. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

### 3.5 GROUNDING ELECTRODE SYSTEM

- A. Bond to grounding electrodes at adjacent City Center Building as shown on the drawings.
- B. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main grounding bus to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- C. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

**END OF SECTION 26 05 26**

## SECTION 26 05 33 - CONDUIT AND BOXES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Rigid metallic conduit and fittings
- B. Intermediate metallic conduit and fittings
- C. Electrical metallic tubing and fittings
- D. Flexible metallic conduit and fittings
- E. Liquidtight flexible metallic conduit and fittings
- F. Rigid polyvinyl chloride conduit and fittings
- G. Wall and ceiling outlet boxes
- H. Electrical connection
- I. Pull and junction boxes
- J. Accessories

#### 1.2 REFERENCES

- A. American National Standards Institute (ANSI):
  - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
  - 2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
  - 3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
  - 4. ANSI C80.6 – Intermediate Metal Conduit, Zinc Coated
  - 5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
- B. Federal Specifications (FS):
  - 1. A–A–50553A – Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
  - 2. A–A–55810 – Specification for Flexible Metal Conduit
- C. NECA “Standards of Installation”
- D. National Electrical Manufacturers Association (NEMA):
  - 1. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
  - 2. RN 1 – Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
  - 3. TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit
  - 4. TC 9 – Fittings for PVC Plastic Utilities Duct for Underground Installation
- E. National Fire Protection Association (NFPA):
  - 1. ANSI/NFPA 70 – National Electrical Code
- F. Underwriters Laboratories (UL): Applicable Listings
  - 1. UL 1 – Flexible Metal Conduit
  - 2. UL 6 – Rigid Metal Conduit
  - 3. UL 360 – Liquid Tight Flexible Steel Conduit
  - 4. UL514-B – Conduit Tubing and Cable Fittings
  - 5. UL651-A – Type EB and a PVC Conduit and HDPE Conduit

6. UL746A – Standard for Polymeric Materials – Short Term Property Evaluations
7. UL797 – Electrical Metal Tubing
8. UL1242 – Intermediate Metal Conduit

G. Definitions:

1. Fittings: Conduit connection or coupling.
2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for the purpose of a floor or sub-floor.

## PART 2 - PRODUCTS

### 2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Acceptable Manufacturers:

1. Acceptable Manufacturers: Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or approved equal.
2. Acceptable Manufacturers of RMC Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, Crouse-Hinds, Killark, or approved equal.

B. Minimum Size Galvanized Steel: 3/4 inch (19mm), unless otherwise noted.

C. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.



3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
  4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
  5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.
- D. PVC Externally Coated Conduit: Compliant with UL 6, ANSI C80.1 and NEMA RN 1; rigid galvanized steel conduit with external 40 mil PVC coating and internal 2 mil urethane coating surface. All fittings and conduit bodies shall be complete with coating. Threads shall be hot galvanized and coated with a clear coat of urethane. The PVC coated system shall include necessary PVC coated fittings, boxes and covers to form a complete encapsulated system. Acceptable Manufacturers: Robroy, T&B Ocal or approved equal.

## 2.2 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers: Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or approved equal.
- C. Fittings and Conduit Bodies:
  1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
  2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
  3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
  4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**
  5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

## 2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers of EMT Conduit: Allied, LTV, Steelduct, Wheatland Tube Co, or approved equal.
- C. Fittings and Conduit Bodies:
  1. Compression type of steel designed for their specific application.

2. Acceptable Manufacturers of EMT Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, or approved equal.

#### 2.4 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire.
- B. Acceptable Manufacturers: American Flex, Alfex, Electri-Flex Co, or approved equal.
- C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.
- D. Fittings and Conduit Bodies:
  1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
  2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
  3. Acceptable Manufacturers: O-Z/Gedney Co., Thomas & Betts, Appleton Electric, Electroline, Bridgeport, Midwest, Regal, or approved equal.

#### 2.5 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

- A. Acceptable Manufacturers: Anaconda Type UA, Electri-Flex Type LA, Alfex, Carlon (Lamson & Sessions), or approved equal.
- B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.
- C. Fittings and Conduit Bodies:
  1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
  2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
  3. Acceptable Manufacturers: Appleton Electric, O-Z/Gedney Co., Electroline, Bridgeport, Thomas & Betts, Midwest, Regal, Carlon (Lamson & Sessions), or approved equal.

#### 2.6 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

- A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.
- B. Acceptable Manufacturers: Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or approved equal.

- C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.
- D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

## 2.7 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, minimum of 14 gauge, with 1/2 inch male fixture studs where required.
- B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.
- C. Cast Boxes: NEMA FB1, Type FD, Aluminum or cast ferrous alloy, deep type, gasketed cover, threaded hubs.
- D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.
- E. Outlet boxes shall be 4 inches square with raised cover to fit flush with finish wall line. Coordinate box depth with device requirements and depth of studs where walls are furred out. Multiple gang outlets shall consist of the required number of gang boxes appropriate to the quantity of devices comprising the gang. Where walls are plastered, provide a plaster raised cover. Where outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.

## 2.8 **[ECONN]:** ELECTRICAL CONNECTION

- A. Electrical connection to equipment and motors, sized per NEC. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

## 2.9 **[JB]:** PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Flanged type boxes shall be used where installed flush in wall.

## 2.10 ACCESSORIES

- A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control – IsoBacker Pad, SpecSeal – SSP Putty and Pads, 3M #MPP-4S or equal.

- B. Sound Barrier Insulation Pads: Mastic, non-hardening, sheet material, minimum 1/8" thickness applied to all five sides of back boxes. Kinetics Noise Control – SealTight Backer Pad, L.H. DOTTIE Co., #68 or equal.

## PART 3 - EXECUTION

### 3.1 COLOR CODING

- A. All conduit and box covers shall be color coded to correspond with system type as follows:
- B. Fire Alarm: Red
- C. Emergency Life Safety: Orange
- D. Emergency Optional Standby: Yellow
- E. Temperature Control/Building Automation: Blue

### 3.2 CONDUIT SIZING

- A. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to N.E.C. (Latest Edition). Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the National Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
- B. Minimum Conduit Size (Unless Noted Otherwise):
  - 1. Above Grade: 3/4 inch. (The use of 1/2 inch is allowed for installation conduit to individual lighting control devices, individual receptacles, and individual fixture whips from junction box.)
  - 2. Below Grade: 1 inch.
  - 3. Telecommunication Conduit: 1 inch.
  - 4. Controls Conduit: 3/4 inch.
- C. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

### 3.3 CONDUIT ARRANGEMENT

- A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.
- B. Conduit shall not share the same cell as structural reinforcement in masonry walls.
- C. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the

Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.

- D. Contractor shall adapt his work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
- E. Contractor shall cooperate with all Contractors on the project. He shall obtain details of other Contractor's work in order to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by him. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

### 3.4 CONDUIT SUPPORT

- A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.
- B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.
- C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.
- F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.
- G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed

the National Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

- J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.
- K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the National Electrical Code requirements.
- L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.
- M. Finish:
  - 1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
  - 2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

### 3.5 CONDUIT INSTALLATION

- A. Conduit Connections:
  - 1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
  - 2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
  - 3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
  - 4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.
- B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.
- C. Conduit Bends:
  - 1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
  - 2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).

3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.
4. Telecommunications conduits shall have no more than two (2) 90 degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
  - a. A third bend is acceptable if:
    - 1) The total run is not longer than (33) feet.
    - 2) The conduit size is increased to the next trade size.
5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter into the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications conduit bend radius shall be six (6) times the diameter for conduits under 2" and ten (10) times the diameter for conduits over 2".
7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the National Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer's recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal.

7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, equal to O-Z/Gedney type EYD.
9. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.
10. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
11. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
12. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.

### 3.6 CONDUIT TERMINATIONS

- A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, or approved equal.
- B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.
- C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.
- D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.
- E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.
- F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.



- G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of any and all foreign matter prior to any wires or pull cords being installed.

### 3.7 CONDUIT INSTALLATION SCHEDULE

- A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If This Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the National Electrical Code shall be required.
- B. The following schedule shall be adhered to unless they constitute a violation of applicable codes or are noted otherwise on the drawings. The installation of RMC conduit will be permitted in place of any and all conduit specified in this schedule.
  - 1. Dry Interior Locations, including Utility Tunnels: EMT
    - a. Conduit shall be concealed in all finished spaces unless otherwise noted.
  - 2. Wet or Damp Locations, including any exposed conduit in Ice Carving Lab or cold storage: RMC or IMC with conduit, boxes and fittings installed and equipped so as to prevent water from entering the conduit system.
  - 3. Below grade: RMC or IMC through building foundation. Schedule 40 PVC may be utilized for other locations.

### 3.8 BOX INSTALLATION SCHEDULE

- A. Galvanized steel boxes may be used in:
  - 1. Concealed interior locations above ceilings and in hollow studded partitions.
  - 2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
  - 3. Direct contact with concrete except slab on grade.
  - 4. Recessed in wall of Ice Carving Lab.
- B. Cast boxes shall be used in:
  - 1. Exterior locations.
  - 2. Exposed interior locations within 8' of the highest platform level.
  - 3. Direct contact with earth.
  - 4. Direct contact with concrete in slab on grade.
  - 5. Wet locations.
  - 6. Exposed in Ice Carving Lab and cold storage.

### 3.9 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of boxes and outlets in offices and work areas prior to rough-in.

- C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.
- D. Locate and install to maintain headroom and to present a neat appearance.
- E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

### 3.10 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
  - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
  - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.
- C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
- D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
- E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- F. Provide knockout closures for unused openings.
- G. Support boxes independently of conduit.
- H. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- I. Install boxes in walls without damaging wall insulation.
- J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.
- K. Position outlets to locate luminaires as shown on reflected ceiling drawings.

- L. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
- M. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- N. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- O. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

### 3.11 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit.
- C. Do not install boxes back-to-back in walls.
  - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
  - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

### 3.12 EXPOSED BOX INSTALLATION

- A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
- B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
- C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
- D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.
- E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)

F. Wood, plastic, or fiber plugs shall not be used for fastenings.

**END OF SECTION 26 05 33**

## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Nameplates and tape labels
- B. Wire and cable markers
- C. Conduit labeling
- D. Conduit color coding
- E. Conductor color coding
- F. Electrical gear labeling
- G. Power distribution equipment labeling
- H. Transformer equipment labeling

#### 1.2 REFERENCES

- A. ANSI C2 – National Electrical Safety Code
- B. NFPA 70 – National Electrical Code
- C. ANSI A13.1 – Standard for Pipe Identification
- D. ANSI Z535.4 – Standard for Product Safety Signs and Labels

### PART 2 - PRODUCTS

#### 2.1 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- B. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- D. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.
- E. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.
- F. Aluminum, Wraparound Marker Bands: 1" in width, .014 inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- G. Brass or aluminum Tags: 2" by 2" by .05-inch metal tags with stamped legend, punched for fastener.

- H. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label, minimum of 3/4" high x 9/16" wide, with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

## 2.2 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners. Engraving legend shall be as follows:
  - 1. Black letters on white face for normal power.
  - 2. White letters on red face for emergency power.
  - 3. White letters on green face for grounding.
  - 4. Black letter on yellow face for Caution or UPS.
- B. Baked–Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- C. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with .0396 inch galvanized-steel backing; and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- E. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instruction and requirements of NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.
- D. Circuit Identification: Tag or label conductors as follows:
  - 1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
  - 2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at

terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.

3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- E. Apply warning, caution and instruction signs as follows:
1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
  2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- F. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
- G. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- H. Install ARC FLASH WARNING signs on all power distribution equipment shown on the One Line Diagram such as panelboards and transformers. Refer to Section 26 05 73.

### 3.2 RECEPTACLE AND CONNECTION IDENTIFICATION

- A. Provide identification on all receptacle cover plates and hardwired connections to equipment. Identification shall indicate source and circuit number serving the device (i.e. "R1L1-4").
- B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters in normal size "Swiss 721 Bold" font. Letter and number size to 3/16-inch high. Embossed Dymo-Tape labels are not acceptable.
- C. Permanently affix identification label to cover plates, centered above the receptacle openings. For equipment connections, affix label to equipment at point of connection.

### 3.3 BOX IDENTIFICATION

- A. All junction, pull, and connection boxes shall be identified as follows:
  1. For power and lighting circuits, indicate system voltage and identity of contained circuits ("120V, 1LA1-3,5,7").
  2. For other wiring, indicate system type and description of wiring ("FIRE ALARM NAC #1").

B. Box covers shall be painted to correspond with system type as follows:

1. Fire Alarm: Red
2. Life Safety Emergency Branch: Orange
3. Optional Emergency Branch: Yellow
4. Temperature Control/Building Automation: Blue

### 3.4 CONDUIT IDENTIFICATION

A. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:

1. Fire Alarm: Red
2. Life Safety Emergency Branch: Orange
3. Optional Emergency Branch: Yellow
4. Temperature Control/Building Automation: Blue

B. Blank conduit ends or outlet boxes for future extension of system shall have permanent identification marker indicating purpose of conduit or box and where the raceway originated.

### 3.5 CONDUCTOR COLOR CODING

A. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.

B. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

C. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders and branch circuits, shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel, in colors specified below. The tape shall be applied at each conductor termination with two 1-inch tape bands at 6-inch centers. Contractor option to use colored cabling in lieu of the tape at each end for conductor 6 AWG to 500 KCM.

D. Wire and cables smaller than 6 AWG shall be color coded by the manufacturer.

E. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.

F. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.

G. Conductors shall be color coded as follows:

1. 208Y/120 Volt, 4-Wire:
  - a. A-Phase – Black
  - b. B-Phase – Red
  - c. C-Phase – Blue
  - d. Neutral – White



- e. Ground Bond – Green
2. 480Y/277 Volt, 4-Wire:
- a. A-Phase – Brown
  - b. B-Phase – Orange
  - c. C-Phase – Yellow
  - d. Neutral – Gray
  - e. Ground Bond – Green

### 3.6 CONTROL EQUIPMENT IDENTIFICATION

- A. Provide identification on the front of all control equipment, such as disconnect switches, starters, VFDs, contactors, etc. Nameplate text shall be a minimum of 1/4" high.
- B. Labeling shall include:
  - 1. Equipment type and contract documents designation of equipment being served.
  - 2. Location of equipment being served if it is not located within sight.
  - 3. Voltage and phase of circuit(s).
  - 4. Panel and circuit number(s) serving the equipment.

EXHAUST FAN EF-1 ("LOCATED ON ROOF")  
 480V, 3-PHASE  
 FED FROM "1HA1-1"

### 3.7 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

- A. Provide identification on the front of all power distribution equipment, such as panelboards, switchboards, etc. The identification material shall be engraved plastic-laminated labels. Text shall be a minimum of 1/4" high, Swiss 721 Bold.
- B. Labeling shall include:
  - 1. Equipment type and contract documents designation of equipment.
  - 2. Voltage of the equipment.
  - 3. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.

DISTRIBUTION PANEL DP-H1  
 480Y/277V  
 FED FROM SWITCHBOARD "SB-1"  
 (LOCATED IN MAIN ELECTRIC ROOM)

- C. A separate nameplate for the service entrance equipment shall be labeled with the MAXIMUM AVAILABLE FAULT CURRENT and DATE of calculation given on the one-line diagram.
- D. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1").
- E. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all

circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 05 00 for other requirements.

### 3.8 TRANSFORMER EQUIPMENT IDENTIFICATION

- A. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label. Text shall be a minimum of 1/4" high.
- B. Labeling shall include:
  - 1. Equipment type and contract documents designation of equipment
  - 2. Name of the upstream equipment.
  - 3. Voltage and rating of the equipment.
  - 4. Location of the upstream equipment if it is not located within sight.

TRANSFORMER TR-15 480V: 208Y/120V 15KVA FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELECTRIC ROOM)
--

**END OF SECTION 26 05 53**

## **SECTION 26 05 73 - POWER SYSTEM STUDY**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Short-circuit analysis and report.
- B. Arc-flash hazard analysis and report.

#### **1.2 SUBMITTALS**

- A. Submit documentation of the analyses and reports.
- B. Power system study submittals shall be submitted with the submittals for new equipment (panelboards, transformers, etc.) included in the analysis. The equipment submittals will not be reviewed without this documentation.

#### **1.3 GENERAL**

- A. Analyses shall bear the seal/signature of the licensed Professional Engineer who supervised the analysis.
- B. The input for the power system study shall be based on the contract documents, with estimated conductor lengths provided by the Electrical Contractor.

### **PART 2 - PRODUCTS - NOT USED**

### **PART 3 - EXECUTION**

#### **3.1 SHORT-CIRCUIT ANALYSIS**

- A. Provide a complete short-circuit analysis from the point of connection to the existing City Center Building to and including the entire building distribution as shown on the drawings.
- B. Documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. Fault current calculations shall be made at the main bus of each switchboard, distribution panel, and branch circuit panel. A summary of the fault currents available shall also be submitted.

#### **3.2 ARC FLASH HAZARD ANALYSIS**

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, panelboards, busway, transfer switches, etc.) where work could be performed on energized parts.
- C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm<sup>2</sup>.
- D. 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.

Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

- E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
  - G. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.
  - H. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
  - I. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
  - J. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.
  - K. Mis-coordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
  - L. 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 1584-2002 section.
  - M. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
  - N. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchgear, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.
  - O. The label shall include the incident energy calculated in the analysis and the hazard category or appropriate personal protective equipment (PPE) required to perform maintenance on the system when energized. Labels shall be vinyl or laminated, with a self-adhesive backing.

P. Examples showing the minimum required information follow:

<b>Arc Flash Information</b>	
<b>Category</b> <b>0</b>	Use this information in accordance with applicable OSHA standards, NFPA 70C, and other required safe electrical work practices.
18 inches Flash Protection Boundary 1.2 cal/cm <sup>2</sup> Max Incident Energy at 18" Working Distance Category 0 PPE Category (Per NFPA 70E-2009)	
480 VAC Shock hazard when cover is open 42 inches Limited Approach 12 inches Restricted Approach 1 inch Prohibited Approach } Per NFPA 70E-2009	
Eqpt Name: LPS	Date: 12/26/08
Copyright © 2006 Schneider Electric All Rights Reserved	

### 3.3 ADJUSTMENTS

A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study.

**END OF SECTION 26 05 73**



## **SECTION 26 09 33 - LIGHTING CONTROL SYSTEMS**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Lighting control system

#### **1.2 REFERENCES**

- A. ANSI/NFPA 70 - National Electrical Code
- B. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference
- C. UL Standard 916 Energy Management Equipment
- D. FS W S 896 Switch, Toggle
- E. NEMA WD 1 – General Color Requirements for Wiring Devices
- F. NEMA WD 6 – Wiring Devices – Dimensional Requirements
- G. UL 924 - Emergency Lighting and Power Equipment
- H. UL 1472 – Solid-State Dimming Controls

#### **1.3 SUBMITTALS**

- A. Submit product data under provisions of Section 26 05 00.
- B. Submit product data showing configurations, finishes, dimensions, electrical characteristics, and manufacturer's instructions for all components such as switches, dimmers, control stations, sensors, relays, power supplies, and accessory modules.
- C. Submit control wiring diagrams showing all equipment, line voltage and control wiring requirements, and programming instructions for each sequence of operation.
- D. Submit manufacturer sensor coverage patterns applicable to this project. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.
- E. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

#### **1.4 PROJECT RECORD DOCUMENTS**

- A. Submit project record documents under provisions of Section 26 05 00.
- B. Accurately record location of all devices and equipment, including items located above the ceiling. Include description of switching and circuiting arrangements.

#### **1.5 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data under provisions of Section 26 05 00.

- B. Data shall include the following:
  - 1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.
  - 2. Recommended setting for devices and components where applicable.
  - 3. Replacement part numbers for all system components.

## 1.6 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying lighting design documents describe the minimum material quality, required features, and operational requirements of the lighting control system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Contractor and system manufacturer/vendor are solely responsible for determining all equipment, wiring, and programming required for a complete and operational system.
- B. Provide an integrated lighting control system consisting of all devices, sensors, switches, relays, controllers, wiring, programming, etc. necessary to meet the requirements of the Sequence of Operation, Drawings, and Specifications.
  - 1. Sequence of Operation: Describes the required operation and performance for lighting control in each space. Sequences of Operation are indicated on the drawings.
  - 2. Drawings: The drawings include sequences of operation, locations of control interface devices, sensors, and control zones. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.
  - 3. The Contractor is responsible for confirming that luminaires and controls interoperate as a single system.
- C. The following system types and features are acceptable:
  - 1. Distributed Architecture: Control equipment is located in the space/zone being controlled; not reliant on centralized controllers
  - 2. Standalone Devices: Control equipment consists of traditional wiring devices and equipment such as line voltage switches, line voltage occupancy/vacancy sensor switches, non-intelligent relays, contactors, etc.
  - 3. Control equipment shall match the existing equipment used in the adjacent City Center Building.
- D. The following system types and features are not acceptable:
  - 1. Centralized Architecture: Control equipment is located in a central location serving multiple spaces/zones.
  - 2. Wireless Equipment



## 1.7 WARRANTY

- A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of system start-up or substantial completion, whichever is later.
- B. Occupancy, vacancy, daylight sensors and controls shall have a five (5) year warranty date of system start-up or substantial completion, whichever is later.

## PART 2 PRODUCTS

### 2.1 CONTROL INTERFACES

- A. Refer to Electrical Symbols List for device type.
- B. Colors: All device and coverplate colors shall be verified with Architect, unless indicated otherwise.
- C. Coverplates: Match type specified in Section 26 27 26 "Wiring Devices".
- D. **[SW-PB]:** Wall Control Interface
  - 1. Wall control interface to provide all control functions indicated in the Sequence of Operation.
  - 2. Acceptable Manufacturer: Sensor Switch SPODM
- E. **[SW-1P]:** Single Pole Switch:
  - 1. Single throw, 120/277 volt, 20 amp maintained contact. Toggle handle, side and back wired.
  - 2. Approved Manufacturers: Hubbell HBL1221, Leviton 1221-2, Cooper AH1221.
- F. **[SW-1P-ADJ]:** Local Timer Switch:
  - 1. User adjustable timeout, 120/277 volt, 800/1200 watt rating. No minimum load requirement. Flashes lights one minute before timeout.
  - 2. Approved Manufacturers: Sensor Switch, WattStopper, Hubbell
- G. **[SW-1P-K]:** Key Lock Single Pole Switch:
  - 1. Single throw, 120/277 volt, 20 amp maintained contact. Side and back wired. Provide key to Using Agency.
  - 2. Approved Manufacturers: Hubbell HBL1221L, Leviton 1221-2L, Cooper AH1221L.
- H. **[SW-1P-PL]:** Red Pilot Light Single Pole Switch:
  - 1. 120 volt maintained contact. Toggle handle. Pilot light on when contact closed (switch on). Side and back wired.
  - 2. Approved Manufacturers: Hubbell HBL1221PL, Leviton 1221-PLR, Pass & Seymour PS20AC1-RPL, Cooper AH1221PL.

- I. **[SW-3W]:** Three-way Switch:
  - 1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
  - 2. Approved Manufacturers: Hubbell 1223, Leviton 1223-2, Cooper AH1223.
- J. **[SW-4W]:** Four-way Switch:
  - 1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
  - 2. Approved Manufacturers: Hubbell 1224, Leviton 1224-2, Cooper AH1224.
- K. **[SW-OC-W]:** Wall Switch Occupancy/Vacancy Sensor:
  - 1. 120/277 volt, passive infrared, zero crossing circuitry, adjustable sensitivity and time delay, no minimum load requirements
  - 2. Devices with a "V" subscript on the Drawings shall have manual on operation (vacancy sensor). Devices with an "O" subscript on the Drawings shall have auto on operation (occupancy sensor).
  - 3. Approved Manufacturers: Sensor Switch WSX, Watt Stopper PW-100, Hubbell AP1277

## 2.2 INDOOR OCCUPANCY/VACANCY SENSORS

- A. **[SW-VS-D] or [SW-OC-D]:** Occupancy/Vacancy Sensor - Dual-Technology Type:
  - 1. Ceiling mounted with 360-degree coverage pattern
  - 2. Dual technology using passive infrared acoustic detection methods.
  - 3. Sensitivity Adjustment: Separate for each sensing technology.
  - 4. Acceptable Manufacturer: Sensor Switch CM-PDT series
- B. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. "Vacancy" sensors shall have manual on operation. "Occupancy" sensors shall have automatic on operation.
- C. Mounting:
  - 1. Sensor: Suitable for mounting in any position on a standard outlet box.
  - 2. Time Delay and Sensitivity Adjustments: Recessed and concealed.
- D. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
- E. Bypass Switch: Override the on function in case of sensor failure.
- F. Detection Coverage:
  - a. Task Areas: Detect occupancy anywhere in an area based on hand motion.

- b. Circulation Areas: Detect occupancy anywhere in an area based upon half-step walking motion.

## 2.3 INDOOR DAYLIGHT SENSORS

- A. **[SW-LS-D]:** Daylight Sensor - One Zone Dimming:
  - 1. Dimming control of one zone. Range of 10 to 200 FC. Adjustable deadband prevents cycling. Adjustable time delay. Dimming protocol shall match that of controlled luminaires.
- B. Sensor shall detect changes in ambient light level and provide triggering of lighting groups in area based on sequence of operation.
- C. Sensor shall be configurable via DIP switches at device or via handheld wireless remote programming unit. Settings shall include:
  - 1. Ambient sensitivity range between 1 and 1,000 foot-candles.
  - 2. Time delay of 5 to 300 seconds.
  - 3. Trigger setpoints with deadband adjustment.
- D. Sensor shall provide on/off setpoints as shown in the sequence of operation.
- E. Sensor shall be ceiling- or wall-mounted for range and viewing angle meeting application requirements as outlined in the sequence of operation.
- F. Output signal from sensor shall be linear with light level.
- G. Acceptable Manufacturer: Sensor Switch

## 2.4 RELAYS

- A. Relays shall have dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13 amp tungsten at 120 VAC, and for 1 hp at 120 VAC.

## 2.5 WIRING

- A. Provide all line voltage and control wiring as required by the manufacturer.
- B. Where installed with the line voltage wiring, control wiring shall be copper conductors with insulation voltage rating and temperature rating equal to that of the line voltage wiring, complying with Section 26 05 13 "Wire and Cable."

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.
- C. Verify that required utilities are available, in proper location, and ready for use.

- D. Beginning of installation means installer accepts existing conditions.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings.
- B. All line voltage wiring shall be installed in conduit. Class II low voltage control wiring may be open wiring and shall maintain 150 mm (6 inch) spacing from electronic ballasts/drivers and other RF/EMI sources.\
- C. Mask sensors where necessary to prevent nuisance switching from adjacent areas.

### 3.3 SUPPORT SERVICES

- A. System Startup:
  - 1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.
- B. Testing:
  - 1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.
  - 2. Programming of initial zones, schedules, lighting levels, and sensor settings shall be performed by a factory-authorized technician. The Sequence of Operation on the drawings shall serve as a basis for programming; however, all final settings shall be at the direction of the Owner. The following procedures shall be performed at a minimum:
    - a. Confirm occupancy/vacancy sensor placement, sensitivity, and time delay settings to meet specified performance criteria.
    - b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.
    - c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner's operating requirements.
  - 3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.
  - 4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.
    - a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
    - b. Mask occupancy sensors where necessary to prevent nuisance switching from adjacent areas.

- C. Training:
1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.
  2. Training duration shall be no less than two hours.
- D. Documentation:
1. Manufacturer shall provide system documentation including:
    - a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or BMS/BAS interface unit.
    - b. Drawings for each panel showing hardware configuration and numbering.
    - c. Panel wiring schedules.
    - d. Typical diagrams for each component.

**END OF SECTION 26 09 33**



## **SECTION 26 22 00 - DRY TYPE TRANSFORMERS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Dry type two winding transformers [TR-#]

#### **1.2 REFERENCES**

- A. NEMA - ST 1 - Specialty Transformers
- B. NEMA ST 20 - Dry Type Transformers for General Applications
- C. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers
- D. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers
- E. Department of Energy 10 CFR Part 431 – Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
- F. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- G. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

#### **1.3 SUBMITTALS**

- A. Submit product data under provisions of Section 26 05 00.
- B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Store and protect products under provisions of Section 26 05 00.
- B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

### **PART 2 - PRODUCTS**

#### **2.1 DRY TYPE TWO WINDING TRANSFORMERS**

- A. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.

B. Insulation system and average winding temperature rise for rated KVA as follows:

<b>Ratings</b>	<b>Class</b>	<b>Rise (degree C)</b>
Less than 15	185	As shown on the drawings
15 or higher	220	As shown on the drawings

C. Case temperature shall not exceed 40°C rise above ambient at its warmest point.

D. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

E. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.

F. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

Equivalent Winding kVA Range	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

G. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

H. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

I. Coil Conductors: Continuous windings with terminations brazed or welded.

J. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.

K. Isolate core and coil from enclosure using vibration-absorbing mounts.

L. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

## 2.2 ACCESSORIES

A. Electronic Isolation Shield:

1. Provide electrostatic winding shield with separate insulated grounding connection as shown on the drawings.



## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Set transformer plumb and level.
- B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Mount transformers on four 3"x3"x1/2" thick, 50 durometer rubber vibration isolating pads suitable for isolating the transformer noise from the building structure.

### 3.2 FIELD QUALITY CONTROL

- A. Check for damage and tight connections prior to energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.

**END OF SECTION 26 22 00**



## SECTION 26 24 16 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Distribution panelboards: **[DP-#]**
- B. Lighting and appliance branch circuit panelboards: **[Panel '###']**

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram and Panel Schedules for size, rating, and configuration.

#### 1.3 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers
- B. NEMA PB 1 - Panelboards
- C. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
- D. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment
- E. UL 67 - Panelboards

#### 1.4 SUBMITTALS

- A. Submit shop drawings for equipment and component devices under provisions of Section 26 05 00.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- C. Selective coordination study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.

#### 1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.

### PART 2 - PRODUCTS

#### 2.1 RATINGS

- A. Definitions:
  - 1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 05 53 for additional requirements.

2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
- B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

## 2.2 DISTRIBUTION PANELBOARDS

- A. Approved Manufacturer: Eaton
- B. Panelboards: NEMA PB 1; type as shown on the drawings.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with hinged door and flush lock. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.
- G. Minimum Integrated Short Circuit Rating: As shown on drawings.
- H. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

## 2.3 BRANCH CIRCUIT PANELBOARDS

- A. Approved Manufacturer: Eaton
- B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.
- G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.
- H. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.
- J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.
- B. Height: 6 feet to handle of highest device.
- C. Provide filler plates for unused spaces in panelboards.
- D. Provide typed circuit directory for each branch circuit panelboard. Label each circuit with the type of load and the name and number of the area served. Revise directory to reflect circuit changes required to balance phase loads.
- E. Stub five (5) empty one inch conduits to accessible location above ceiling out of each recessed panelboard.

### 3.2 FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

**END OF SECTION 26 24 16**



## **SECTION 26 24 19 - MOTOR CONTROL**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Manual motor starters
- B. Magnetic motor starters

#### **1.2 RELATED SECTIONS AND WORK**

- A. Refer to the Disconnect and Starter Schedule and One-Line Diagram for rating and configuration.

#### **1.3 REFERENCES**

- A. ANSI/UL Standard 508. Standard for Industrial Control Equipment
- B. FCC Rules and Regulations, Part 15, Subpart J- Radio Frequency Interference
- C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
- D. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted
- E. IEEE Standard 519-1981 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- F. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies
- G. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- H. NEMA KS 1 - Enclosed Switches

#### **1.4 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Section 26 05 00.
- B. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.

#### **1.5 SPARE PARTS**

- A. Keys: Furnish four (4) each to the Owner.
- B. Fuses: Furnish three (3) spare fuses of each type and rating installed to the Owner.
- C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

#### **1.6 OPERATION AND MAINTENANCE DATA**

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## PART 2 - PRODUCTS

### 2.1 MANUAL MOTOR STARTERS

- A. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, and toggle operator.
- B. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.
- C. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.
- D. Enclosure: NEMA ICS 6; Type 1.

### 2.2 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- B. Full Voltage Starting: Non-reversing type, unless otherwise indicated.
- C. Coil Operating Voltage: 120 volts, 60 Hertz, obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating, and control devices, plus 100% spare capacity.
- D. Size: NEMA ICS 2; size as shown on the drawings.
- E. Overload Relay:
  - 1. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- F. Enclosure: NEMA ICS 6; Type 1.
- G. Combination Motor Starters: Combine motor starters with disconnect switch in common enclosure. Provide with disconnecting means as indicated on drawings.
- H. Auxiliary Contacts: NEMA ICS 2; two normally open, field convertible contacts in addition to seal-in contact.
- I. Pushbuttons: NEMA ICS 2; START/STOP in front cover.
- J. Indicating Lights: NEMA ICS 2; RUN: red in front cover.
- K. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.



- L. Control Power Transformers: 120 volt fused secondary, fused primary, minimum VA as scheduled:
  - Size 1 - 100 VA
  - Size 2 - 100 VA
  - Size 3 - 150 VA
  - Size 4 - 300 VA
  - Size 5 - 300 VA
  - Size 6 - 300 VA
- M. Provide phase loss protection relay with contacts to de-energize the starter for each starter serving motors 5 HP or greater.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions on concrete bases.
- B. Install fuses in fusible switches.
- C. Select and install heater elements in motor starters to match installed motor characteristics.
- D. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

**END OF SECTION 26 24 19**



## **SECTION 26 27 26 - WIRING DEVICES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Device plates and box covers
- B. Receptacles

#### **1.2 QUALITY ASSURANCE**

- A. Provide similar devices from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
- C. Comply with NFPA 70.

#### **1.3 REFERENCES**

- A. DSCC W-C-896F – General Specification for Electrical Power Connector
- B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet
- C. NEMA WD 1 – General Color Requirements for Wiring Devices
- D. NEMA WD 6 – Wiring Devices – Dimensional Requirements
- E. UL 498 – Standard for Attachment Plugs and Receptacles
- F. UL 943 – Standard for Ground Fault Circuit Interrupters

#### **1.4 SUBMITTALS**

- A. Submit product data under provisions of Section 26 05 00.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

#### **1.5 COORDINATION**

- A. Receptacles for Owner Furnished Equipment: Match plug configurations.
- B. Cord and Plug Sets: Match equipment requirements.

### **PART 2 - PRODUCTS**

#### **2.1 DEVICE COLOR**

- A. All device and coverplate colors shall be verified with Architect, unless indicated otherwise.

## 2.2 COVERPLATES

- A. All receptacles and outlets shall be complete with the following:
  - 1. Unbreakable thermoplastic/thermoset plastic coverplates in finished spaces where wall are finished.
  - 2. #302 stainless steel coverplates in unfinished spaces for flush boxes.
  - 3. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 26 05 53.
- D. Plate securing screws shall be metal with head color matching the wall plate finish.

## 2.3 RECEPTACLES

- A. Refer to Electrical Symbols List for device type.
- B. Devices that are shaded on the drawings shall be red.
- C. **[REC-DUP]:** NEMA 5-20R Duplex Receptacle:
  - 1. 125 volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.
  - 2. Approved Manufacturers: Hubbell 5352A, Leviton, 5362-S, Cooper 5352.
- D. **[REC-DUP-GFI]:** NEMA 5-20R Ground Fault Duplex Receptacle:
  - 1. 125 volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
  - 2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
  - 3. Approved Manufacturers: Hubbell GF20L, Leviton GFNT2, Cooper SGF20.
- E. **[REC-DUP-WP]:** NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:
  - 1. 125 volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face. Provide NEMA 3R rated while-in-use clear cover.
  - 2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
  - 3. Approved Manufacturers: Hubbell GFTR20/RW57300, Leviton GFWT2/5977-CL, Cooper WRSGF20/WIU-1.
- F. **[REC-QUAD]:** NEMA 5-20R Double Duplex Receptacle:
  - 1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
  - 2. Approved manufacturers: Refer to Duplex Receptacle above.

- G. **[REC-QUAD-WP]:** NEMA 5-20R Weatherproof Ground Fault Quad Receptacle:
1. Consists of two duplex, GFI receptacles. Double gang box. Provide NEMA 3R rated while-in-use cast aluminum cover.
  2. Approved Manufacturers:
    - a. Receptacle: Refer to GFCI Receptacle above.
    - b. Cover: Intermatic WP1030MXD, Pass & Seymour WIUCAST2, Thomas & Betts Red Dot 2CKU.
- H. **[REC-QUAD-VAC]:** NEMA 5-20R Double Duplex Receptacle, half controlled by vacancy sensor:
1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
  2. One duplex receptacle is constantly connected to supply power and one duplex receptacle is controlled by the vacancy sensor serving room via a slave relay pack. Refer to control diagrams on Drawings.
  3. Controlled duplex receptacle shall be green in color.
  4. Coverplate shall have label reading "CONTROLLED" centered above the controlled duplex receptacle.
  5. Approved manufacturers: Refer to Duplex Receptacle [REC-DUP] above.
- I. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.
- J. Side wired devices shall have four binding screws that are undercut for positive wire retention.
- K. Ground Fault Circuit Interrupter (GFCI) receptacles shall comply with the 2006 edition of U.L. 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.
- B. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.
- C. Install decorative plates on receptacle and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.
- D. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

- E. Install devices and wall plates flush and level.
- F. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 05 53 - Electrical Identification.
- G. Test receptacles for proper polarity, ground continuity and compliance with requirements.

**END OF SECTION 26 27 26**

## SECTION 26 28 16 - DISCONNECT SWITCHES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Disconnect switches

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule for rating and configuration.

#### 1.3 REFERENCES

- A. NEMA KS 1 - Enclosed Switches

#### 1.4 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Product Data: For each type of enclosed switch, circuit breaker, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
- C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

#### 1.5 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

### PART 2 - PRODUCTS

#### 2.1 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. **[FDS-#]:** Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.
- B. **[DS-#]:** Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- C. Enclosures: Type as indicated on the disconnect schedule.
- D. Accessories: As indicated on the disconnect schedule.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install disconnect switches where indicated on the drawings.
- B. Install fuses in fusible disconnect switches.
- C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

**END OF SECTION 26 28 16**



## SECTION 26 28 21 - CONTACTORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Lighting contactors
- B. Enclosures

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to Lighting Contactor Schedule.

#### 1.3 REFERENCES

- A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- B. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies
- C. UL 508 - Industrial Control Equipment

#### 1.4 SUBMITTALS

- A. Submit shop drawings under provisions of Section 26 05 00.
- B. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, and poles.
- C. Submit manufacturer's instructions under provisions of Section 26 05 00.

### PART 2 - PRODUCTS

#### 2.1 **[LC-#]:** LIGHTING CONTACTORS

- A. Contactors: NEMA ICS 2 and UL 508; electrically held, 2-wire control.
- B. Coil Operating Voltage: 120 volts, 60 Hertz.
- C. Contacts: As indicated on the drawings.
- D. Enclosure: ANSI/NEMA ICS 6; Type 1.
- E. Provide solderless pressure wire terminals.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction boxes: and equipment enclosures.
- E. 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.

**END OF SECTION 26 28 21**

## SECTION 26 41 00 - LIGHTNING PROTECTION SYSTEMS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Extension of Existing Building Lightning Protection System

#### 1.2 REFERENCES

- A. ANSI/NFPA 780 - Lightning Protection Code
- B. ANSI/UL 96 - Lightning Protection Components
- C. LPI-175 - Lightning Protection Institute Installation Standard
- D. LPI-176 - Lightning Protection Institute System Material and Components Standards
- E. UL 96A - Installation Requirements for Lightning Protection Systems

#### 1.3 SYSTEM DESCRIPTION

- A. Extend existing UL Master Label lightning protection system protecting the existing Renaissance Center and City Center Buildings. Provide new lightning protection system components, where necessary, for new roof-mounted mechanical equipment, chimneys, stacks, etc. Provide all necessary air terminals, conductors, and other components as required for a complete system.
- B. Performance Statement: This specification and the accompanying roof plans describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every air terminal, conductor, and connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all equipment and wiring required for a complete and operational system.
- C. Drawings of the existing lightning protection system will be furnished to the Contractor upon request.

#### 1.4 SUBMITTALS

- A. Submit shop drawings showing layout of all system components. Include terminal, electrode, and conductor sizes, and connection and termination details. Include indications for use of raceway and type, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- B. Submit product data for each component, and include indication of listing in accordance with ANSI/UL 96 or a nationally recognized testing laboratory.
- C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.

#### 1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.
- B. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

## 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in lightning protection equipment with minimum three (3) years documented experience or who is listed by a nationally recognized testing laboratory.
- B. Installer: Authorized installer of manufacturer with minimum three (3) years documented experience.
- C. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

## 1.7 SEQUENCING AND SCHEDULING

- A. Coordinate work with other Contractors furnishing and installing roof-mounted equipment.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Heary Brothers Lightning Protection Co., Inc.
- B. Thompson Lightning Protection.
- C. Harger Lightning Protection.
- D. Robbins Lighting, Inc.
- E. Erico International Corporation.

### 2.2 MATERIALS

- A. All materials shall be copper and/or copper-bronze. In locations where the system components are mounted on aluminum surfaces, aluminum materials shall be used to avoid electrolytic corrosion of dissimilar metals.
- B. Components: In accordance with ANSI/UL 96 or nationally recognized testing laboratory.
- C. Air Terminals: Solid, unless otherwise indicated. Provide air terminals with safety 3/4" sphere tip. Provide swivel adapters to plumb air terminals when mounting on sloping surfaces.
- D. Connectors and Splicers: Bronze, unless otherwise indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify that field measurements are as shown on the shop drawings.
- C. Beginning of installation means installer accepts existing conditions.

### 3.2 PROTECTION OF SURROUNDING ELEMENTS

- A. Protect elements surrounding work of this Section from damage or disfiguration.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with ANSI/NFPA 780, UL 96A, and LPI-175.
- C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- D. Conceal the following conductors:
  - 1. System conductors.
  - 2. Down conductors.
  - 3. Interior conductors.
  - 4. Conductors within normal view from exterior locations at grade within 200 feet (60 m) of building.
  - 5. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- E. Bond extremities of metal bodies exceeding 60 feet (18 m) in vertical length to structural steel members.

### 3.4 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.
- C. Bi-metal transition fittings shall be used when changing between aluminum and copper conductors.

### 3.5 FIELD QUALITY CONTROL

- A. Provide inspection and certification of the lightning protection system under provisions of UL 96A to obtain UL Recertified Master Label for the entire system.

**END OF SECTION 26 41 00**



## **SECTION 26 43 00 - SURGE PROTECTION DEVICES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Surge Protection Devices (SPD)

#### **1.2 QUALITY ASSURANCE**

- A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.
- B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment. The qualified manufacturer must have been engaged in the design and manufacturer of such products for a minimum of five years.

#### **1.3 REFERENCES**

- A. ANSI/IEEE C62.33 – IEEE Guide on Testing of MOV components
- B. ANSI/IEEE C62.35 – IEEE Guide on Testing of SAD components
- C. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits
- D. ANSI/IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits
- E. ANSI/UL 1449 Third Edition (Version 3.0) - UL Standard for Safety for Surge Protective Devices
- F. CBEMA – Computer Business Equipment Manufacturers Association
- G. IEC 664 – International Engineering Consortium, Standard for Clamping Voltage
- H. National Electrical Code 285 - Surge Protection Devices
- I. NFPA 70 - National Electrical Code
- J. UL 67 – Listed for Internal Panelboard Transient Voltage Surge Suppressors
- K. UL 96A – Devices listed as approved for secondary surge arrestors (VZCA)
- L. UL 248-1 - Fusing
- M. UL 1283 – Electromagnetic Interference Filters, Fifth Edition

#### **1.4 SUBMITTALS**

- A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under "Testing, Warranty and Life Expectancy" as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate

IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.

- B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

## 1.5 SPARE PARTS

- A. Surge Protection Modules: Furnish 1 replacement module for each type installed.
- B. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.

## 1.6 TESTING, WARRANTY AND LIFE EXPECTANCY

- A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.
  - 1. Single pulse surge current capacity: Single pulse surge current tested in a mode at rated surge currents.
  - 2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50 $\mu$ s, 6000V open circuit voltage waveform and an 8 x 20 $\mu$ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage (VPR).
  - 3. A single 8 x 20 $\mu$ s waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
- B. Minimum Repetitive Surge Current Capacity:
  - 1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
  - 2. Minimum Repetitive Surge Current Capacity Test:
    - a. An initial UL 1449 surge defined as 1.2 x 50 $\mu$ s, 6000V open circuit voltage waveform and an 8 x 20 $\mu$ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage.
    - b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50 $\mu$ s 10kV or 20kV open circuit voltage waveform and an 8 x 20 $\mu$ s 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
    - c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
  - 3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.



- 4. Proof of such testing shall be the test log generated by the surge generator.
- C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.
- D. Warranty: Ten (10) years. Includes workmanship, installation and programming.
- E. No scheduled parts replacement or preventative maintenance shall be required.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

2.2 RATINGS

- A. **[SPD-2]:** Secondary Distribution Suppressors:
  - 1. For 120/208 volt, 3 phase, 4 wire, type 2, category B3/C1 unit.
    - a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
    - b. Nominal Discharge Current ( $I_N$ ): 20 kA.
    - c. Mounting: Refer to the drawings.
    - d. Voltage Protection Rating: Refer to requirements below.
    - e. Components: Minimum component size of 20mm metal oxide varistors (MOV).
  - 2. Approved Manufacturers:
    - a. Current Technology Current Guard Plus
    - b. Emerson Network Power 510 Series
    - c. LEA International CFS Series
- B. EMI/RFI Noise Rejection or Filtering:
  - 1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.
- C. Indication:
  - 1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.

2. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.
  3. Provide each secondary distribution type unit with a transient counter.
  4. Each unit shall contain form "C" contacts for remote indication of an alarm status.
- D. Fuses:
1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.
  2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.
- B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

### 3.2 INSTALLATION

A. Mounting Location:

1. The unit shall be installed as close as practical to the panel secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer's recommended installation instructions. Connect the unit to the panel using a conduit nipple. Mount unit directly across from the breaker or disconnect serving it.

B. Connections:

1. Conductors from the protected bus to the unit shall not be any longer than necessary avoiding unnecessary bends. The conductor leads shall be twisted together and as short as possible. Connection shall be with mechanical lugs for each phase, neutral, and ground if applicable. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the panelboard.
3. Neutral and ground shall not be bonded together at secondary panelboard locations.

C. General:

1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.

3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

**END OF SECTION 26 43 00**



## SECTION 26 51 00 - LIGHTING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Interior luminaires and accessories
- B. Exterior luminaires and accessories

#### 1.2 REFERENCES

- A. ANSI C78.377-2008 – Specifications for the Chromaticity of Solid State Lighting Products
- B. ANSI C82.77-2002 – Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment
- C. IEEE C2 - National Electrical Safety Code

#### 1.3 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Submit product data sheets for luminaires, lamps, ballasts, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with fixtures listed in ascending order, and with each luminaire's associated lamp, ballast, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
- C. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
- D. Include outline drawings, support points, weights, and accessory information for each luminaire type.
- E. LED luminaire submittals shall include photometric report per IESNA LM-79-08 for the latest generation system being furnished, including independent testing laboratory name, report number, date, luminaire model number, input wattage, luminaire, and light source specifications. Manufacturer origin of LED chipset and driver shall be submitted.
- F. For all LED luminaires specified as dimmer controlled, submit dimmer device data that is approved by manufacturer of submitted luminaire and that Contractor proposes to furnish and install. Contractor is responsible for verifying that installed dimming controls are compatible with and approved by the luminaire manufacturer.

#### 1.4 EXTRA STOCK

- A. Provide extra stock under provisions of Section 26 05 00.
- B. LED Light Engines or Modules: Five (5) percent of quantity installed, minimum of one (1) of each size and type.
- C. Lenses: Three (3) percent of quantity installed, minimum of one (1) of each size and type.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site. Store and protect under provisions of Section 26 05 00.

- B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.

## 1.6 WARRANTY

- A. Light emitting diode (LED) light engines and drivers shall have a five-year warranty from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.
- B. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified.
- C. Exit Signs: Stencil face, 6 inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.
- D. Painted reflector surfaces shall have a minimum reflectance of 90%.

### 2.2 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Listed for wet or damp location as scheduled.
- B. Provide low temperature ballasts or LED drivers, with reliable starting to -20°F.

### 2.3 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 80. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 70. Color temperature of the luminaires shall be as noted on the luminaire schedule.
- B. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.
- C. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- D. LED Driver:
  - 1. Solid state driver with integral heat sink. Driver shall have overheat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 20%. Surge suppression device for all exterior luminaires.
  - 2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type.
  - 3. Driver shall have a minimum of 50,000 hours rated life.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Securely fasten luminaires to the ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members.
- B. Install lamps in lamp holders of luminaires.
- C. Support surface-mounted luminaires directly from building structure. Install luminaires larger than eight square feet (8 ft<sup>2</sup>) or weighing more than 30 pounds independent of ceiling framing.
- D. Support suspended or pendant mounted luminaires independent of ceiling grid with a minimum of two #12 gauge wires. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.
- E. Install recessed luminaires to permit removal from below. Use plaster frames or install grid clips. Support luminaires independent of ceiling grid with a minimum of two (2) #12 gauge wires located on diagonal corners.
- F. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.
- G. Louvers and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.
- H. Fire-rated Ceilings: Support luminaires independent of ceiling system with a minimum of two (2) #12 gauge wires.

### 3.2 RELAMPING

- A. Replace failed lamps at completion of work.

### 3.3 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.
- B. Touch up luminaire finish at completion of work.

### 3.4 LUMINAIRE SCHEDULE

- A. As shown on the drawings.

**END OF SECTION 26 51 00**





## SECTION 27 05 00 - BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.

#### 1.2 SCOPE OF WORK

- A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the Communications Systems as shown on the drawings and specified herein.
- B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make their portion of the Communications Systems a finished and working system.
- C. Description of Systems include but are not limited to the following:
  - 1. Complete Structured Cabling System including, but not limited to:
    - a. Voice and data backbone cabling and terminations.
    - b. Voice and data horizontal cabling and terminations.
    - c. Information outlets (IO's) including faceplates, jacks and labeling.
    - d. Equipment racks, cabinets, cable management and equipment.
    - e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
    - f. Cabling pathways.
    - g. Grounding and Bonding
    - h. Testing
  - 2. Complete Audio/Visual Systems.
  - 3. Complete Clock Systems.
  - 4. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.
  - 5. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
  - 6. Firestopping of penetrations as described in Division 27.

#### 1.3 WORK SEQUENCE

- A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.
- B. The successful Bidders shall be responsible for scheduling overtime hours for the following work:

- C. Successful Bidders shall itemize all work and list associated hours and pay scale for each item.

#### 1.4 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

- B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
3. "Communications Contractor" as referred to herein refers to the Contractors listed in Division 27 of this Specification.
4. Low Voltage Communications Wiring: The wiring (less than 120VAC) associated with the Communications Systems, used for analog and/or digital signals between equipment.
5. Telecommunications Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications information outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling the nearest cable tray. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling the bottom of the exposed structural joists the nearest cable tray.

- C. General:

1. The purpose of these Specifications is to outline typical Electrical and Communications Contractor's work responsibilities as related to Communications Systems including Telecommunications rough-in, conduit, cable tray, power wiring and Low Voltage Communications Wiring. The prime contractor is responsible for all divisions of work.
2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Communications Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Communications Drawings but required for the successful operation of the systems shall be the responsibility of the Communications Contractor and included in the Contractor's bid.

3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Communications systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Communications Contractor has convened to determine the exact location and requirements of the installation.
4. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Communications Wiring, the installation shall not begin until the Communications Contractor has completed a coordination review of the cable tray shop drawing.
5. This Contractor shall establish Electrical and Communications utility elevations prior to fabrication and installation. The Communications Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
  - a. Lighting Fixtures
  - b. Gravity Flow Piping, including Steam and Condensate
  - c. Sheet Metal
  - d. Electrical Busduct
  - e. Cable Trays, including 12" access space
  - f. Sprinkler Piping and other Piping
  - g. Conduit and Wireway
  - h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Assumes all responsibility for providing and installing cable tray.
3. Responsible for Communications Systems grounding and bonding.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Communications Contractor's Responsibility:

1. Assumes all responsibility for the Low Voltage Communications Wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of Communications equipment which is required to be bonded to the Communications ground system.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.5 COORDINATION DRAWINGS

### A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

### B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. KJWW will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an

"Electronic File Transfer" waiver provided by KJWW. KJWW will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.6 QUALITY ASSURANCE

### A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:
  - a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling
  - b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises
    - 1) C.1 - Commercial Building Telecommunications Standard
    - 2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard
    - 3) C.3 - Optical Fiber Cabling Components Standard
    - 4) C.4 - Broadband Coaxial Cabling and Components Standard

- c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces
  - d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure
  - e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - f. ANSI/TIA-758-B - Customer-Owned Outside Plant Telecommunications Standard
  - g. ANSI/TIA-862-A - Building Automation Systems Cabling Standard
  - h. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers
  - i. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
  - j. ANSI/TIA-1179 Healthcare Facility Telecommunications Standard
  - k. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding
  - l. NFPA 70 (NEC) - National Electrical Code (Current Edition)
  - m. UL 444 - Standard for Safety for Communications Cable
- B. Refer to individual sections for additional Quality Assurance requirements.
- C. Qualifications:
1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
  2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding this project. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.
  3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.
  4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
  5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.
  6. The Contractor must have a RCDD (Registered Communications Distribution Designer) on-staff serving as a project manager. Project shop drawings and test reports shall be stamped by the RCDD.

7. The Contractor shall have certified BICSI installation technicians on staff to perform the following tasks on the project:
  - a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.
  - b. Oversee all testing and termination of cabling.
8. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
  - a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.

D. Compliance with Codes, Laws, Ordinances:

1. This Contractor shall conform to all requirements of the City of Joliet Codes, Laws, Ordinances and other regulations having jurisdiction over this installation.
2. This Contractor shall also conform to all published standards of Joliet Junior College as related to this installation.
3. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
4. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, the codes and regulations shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

E. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.



6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. Pay any charges by the service provider related to the service or change in service to the project.
8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):
  - a. Factory Mutual
  - b. Underwriters' Laboratories, Inc.

F. Examination of Drawings:

1. The drawings for the Communications Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit MEP.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by KJWW.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by KJWW for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by KJWW as to the accuracy or correctness of the information provided. KJWW accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.
2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.
3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

1.7 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

<b>Referenced Specification</b>	<b>Submittal Item</b>
<u>Section</u>	
28 31 00	Fire Detection and Alarm
27 05 26	Communications Bonding
27 11 00	Communication Equipment Rooms
27 05 28	Interior Communications Pathways
27 05 43	Exterior Communications Pathways
27 13 00	Backbone Cabling Requirements
27 15 00	Horizontal Cabling Requirements
27 05 53	Identification and Administration
27 17 10	Testing
27 53 13	Central Clock System
27 13 43.53	Television Distribution System
27 41 00	Professional Audio Video System

- B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
1. Transmittal: Each transmittal shall include the following:
    - a. Date
    - b. Project title and number
    - c. Contractor's name and address
    - d. Description of items submitted and relevant specification number
    - e. Notations of deviations from the contract documents
    - f. Other pertinent data
  2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
    - a. Date
    - b. Project title and number
    - c. Architect/Engineer
    - d. Contractor and subcontractors' names and addresses
    - e. Supplier and manufacturer's names and addresses
    - f. Description of item submitted (using project nomenclature) and relevant specification number
    - g. Notations of deviations from the contract documents
    - h. Other pertinent data
    - i. Provide space for Contractor's review stamps
  3. Composition:
    - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
    - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
    - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
  4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
  5. Contractor's Approval Stamp:
    - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
    - b. Unstamped submittals will be rejected.
    - c. The Contractor shall provide RCDD stamp on the submittal.

- d. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - e. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - f. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 27 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 27 XX XX.description.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be transmitted via a pre-approved method.

D. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.
2. The Contractor shall submit ten (10) paper copies of each shop drawing.
3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

## 1.8 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

- C. Preparation:
1. Itemize the cost for each of the following:
    - a. Overhead and profit.
    - b. Bonds.
    - c. Insurance.
    - d. General Requirements: Itemize all requirements.
  2. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
    - a. Contractor's own labor forces.
    - b. All subcontractors.
    - c. All major suppliers of products or equipment.
  3. Break down all costs into:
    - a. Material: Delivered cost of product with taxes paid.
    - b. Labor: Labor cost, excluding overhead and profit.
  4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
    - a. Structured Cabling
    - b. Audio/Video Systems
- D. Update Schedule of Values when:
1. Indicated by Architect/Engineer.
  2. Change of Subcontractor or supplier occurs.
  3. Change of product or equipment occurs.

#### 1.9 CHANGE ORDERS

- A. A detailed material and labor take-off shall be prepared for each change order along with labor rates and mark-up percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

#### 1.10 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
  1. Firestopping, including mechanical firestop systems.

#### 1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
- B. Store materials on the site so as to prevent damage.

- C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

#### 1.12 WARRANTY

- A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.
- B. Provide a structured cabling System Assurance Warranty as described herein.
- C. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
- D. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

#### 1.13 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

#### 1.14 MATERIAL

- A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.
- B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured **in writing** from the Architect/Engineer not later than ten (10) days prior to the bid opening date. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.
- D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or

equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

#### 1.15 LEED REQUIREMENTS

- A. This project is pursuing a LEED Certified certification in accordance with USGBC LEED Rating System for New Construction Version 2009. The Contractor shall provide all services and documentation necessary to achieve this rating.

#### PART 2 - PRODUCTS

##### 2.1 REFER TO INDIVIDUAL SECTIONS

#### PART 3 - EXECUTION

##### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

##### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.
- B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.
- C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.
- D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.



### 3.3 FIELD QUALITY CONTROL

#### A. General:

1. Refer to specific Division 27 sections for further requirements.
2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
5. All telecommunications tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

#### B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

### 3.4 PROJECT CLOSEOUT

- #### A.
- Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

- B. Final Jobsite Observation:
1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
  2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
  3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.
- C. Before final payment will be authorized, this Contractor must have completed the following:
1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
  2. Submitted bound copies of approved shop drawings.
  3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
  4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
  5. Submitted testing reports for all systems requiring final testing as described herein.
  6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
  7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site insert address here; submit receipt to Architect/Engineer prior to final payment being approved.
  8. Provide System Assurance Warranty certificate for the telecommunications system.

### 3.5 OPERATION AND MAINTENANCE MANUALS

- A. General:
1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
  2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div27.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 4MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.

7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

### 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.
- E. Refer to the individual specification sections for minimum hours of instruction time for each system.
- F. Operating Instructions:
  1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.
  2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.7 SYSTEM COMMISSIONING

- A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software

configuration, troubleshooting and verification of software, and final adjustments that may be required.

- B. All operating conditions and control sequences shall be simulated and tested during the start-up period.
- C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to insure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.8 RECORD DOCUMENTS

- A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- C. This Contractor shall maintain at the job site, a separate and complete set of Communications Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Communications Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.
- E. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

### 3.9 ADJUST AND CLEAN

- A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.
- C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

### 3.10 SPECIAL REQUIREMENTS

- A. In accordance with LEED EQc4.1, Low-Emitting Materials - Adhesives and Sealants, all adhesives and sealants used on the interior of the building must comply with the following requirements:
1. Adhesives, sealants and sealant primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.
  2. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

### 3.11 CONSTRUCTION WASTE MANAGEMENT

- A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).
1. This Contractor shall coordinate with the Construction Manager to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.
  2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the Construction Manager so that it can be incorporated with similar information from all other contractors for the project.
    - a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the Construction Manager to establish the preferred calculation method and report the results accordingly.
    - b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.
  3. At a minimum, 50% 75% of the construction and demolition debris for this project must be recycled or salvaged.

**END OF SECTION 27 05 00**

## STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

In order to assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (ladder rack, conduit sleeves, etc) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 25% of testing has been completed.
6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All Audio/Visual components, cabling and control systems are installed, programmed and operational.

The project will be ready for final jobsite observation prior to the requested date of the observation, according to the above list of requirement.

Prime Contractor: \_\_\_\_\_ By: \_\_\_\_\_

Requested Observation Date \_\_\_\_\_ Today's Date: \_\_\_\_\_

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

**Telecommunications – Proof of Certification**

There are specific Contractor qualification requirements for this project as defined in Section 27 05 00, which may include Manufacturer Certification and RCDD credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

**Statement of Compliance:**

The named Contractor's base bid is a structured cabling solution from the connectivity manufacturer \_\_\_\_\_. Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: \_\_\_\_\_

Authorized Representative: (print) \_\_\_\_\_

Date: \_\_\_\_\_ Manufacturer Certification Number (if any): \_\_\_\_\_

If this project requires RCDD certification, complete the following:

RCDD Name: \_\_\_\_\_ RCDD #: \_\_\_\_\_ Expiration: \_\_\_\_\_

Submit the following with the bid:

- This form.
- Proof of Manufacturer Certification indicated above.
- Proof of RCDD status.



## **SECTION 27 05 26 - COMMUNICATIONS BONDING**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Bonding Conductors
- B. Bonding Connectors
- C. Grounding Busbar (TMGB and TGB)
- D. Rack-mount Telecommunications Grounding Busbar

#### **1.2 RELATED WORK**

- A. Section 26 05 33 – Conduit
- B. Section 26 05 13 – Wire and Cable
- C. Section 26 05 26 – Grounding and Bonding
- D. Section 26 41 00 – Lightning Protection Systems
- E. Section 27 05 00 – Basic Communications Systems Requirements
- F. Section 26 05 03 – Through Penetration Firestopping
- G. Section 27 11 00 – Communication Equipment Rooms
- H. Section 27 05 28 – Interior Communication Pathways
- I. Section 27 05 53 – Identification and Administration

#### **1.3 QUALITY ASSURANCE**

- A. Refer to Section 27 05 00 for relevant standards.
- B. Communications bonding system component, device, equipment, and material manufacturer(s) shall have a minimum of five (5) years documented experience in the manufacture of communications bonding products.
- C. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

#### **1.4 REFERENCES**

- A. ANSI/IEEE 1100 – Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
- B. ANSI/TIA/EIA 568-C – Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA/EIA 569-A – Commercial Building Standard for Telecommunications Pathways and Spaces
- D. ANSI/TIA/EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- E. ANSI/TIA/EIA 758 – Customer Owned Outside Plant
- F. ANSI-J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- G. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements

- H. IEEE 837 – IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
- I. NFPA 70 – National Electrical Code
- J. NFPA 780 – Standard for the Installation of Lightning Protection Systems
- K. UL 96 – Lightning Protection Components
- L. UL 96A – Installation Requirements for Lightning Protection Systems
- M. UL 467 – Grounding and Bonding Equipment

#### 1.5 SUBMITTALS

- A. Submit product data and shop drawings under provisions of Section 27 05 00 and Division 1.
- B. Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:
  - 1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item, including construction, materials, ratings, and all other parameters identified in Part 2 - Products.
  - 2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- C. Provide CAD-generated, project-specific system shop drawings as follows:
  - 1. Provide a system block diagram indicating system configuration, system components, interconnection between components, and conductor routing. The diagram shall clearly indicate all wiring and connections required in the system. When multiple devices or pieces of equipment are required in the exact same configuration (e.g., multiple identical equipment racks or sections of ladder tray), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where system equipment will be located.
  - 2. Installation details for all system components.
- D. Provide system checkout test procedure to be performed at acceptance.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under the provisions of Section 27 05 00.
- B. Store and protect products under the provisions of Section 27 05 00.
- C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

## 1.7 SYSTEM DESCRIPTION

- A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.
- B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.
- C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.
- D. Basic System Requirements:
  - 1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.
  - 2. The bonding system shall include, but not be limited to, the following major components:
    - a. Bonding Conductor for Telecommunications (BCT)
    - b. Telecommunications Main Grounding Busbar (TMGB)
    - c. Telecommunications Bonding Backbone (TBB)
    - d. Telecommunications Grounding Busbar(s) (TGB)
    - e. Rack mount Telecommunications Grounding Busbar(s)
    - f. Bonding Conductor(s) (BC)
    - g. Bonding Connectors
    - h. Bonding system labeling and administration as defined in Section 27 05 53.

## 1.8 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 27 05 00.
- B. Provide final system block diagram showing any deviations from approved shop drawing submittal.
- C. Provide floor plans that document the following:
  - 1. Actual locations of system components, devices, and equipment.
  - 2. Actual conductor routing.
  - 3. Actual system component, device, equipment, and conductor labels.
- D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.
- E. Complete all operation and maintenance manuals as described below.

1.9 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 27 05 00.
- B. Submitted data shall include:
  - 1. Approved shop drawings.
  - 2. Descriptions of recommended system maintenance procedures, including:
    - a. Inspection
    - b. Periodic preventive maintenance
    - c. Fault diagnosis
    - d. Repair or replacement of defective components

PART 2 - PRODUCTS

2.1 BONDING CONDUCTORS

- A. Bare Copper:
  - 1. Annealed uncoated stranded conductor.
  - 2. Minimum size 6 AWG.
- B. Insulated Copper:
  - 1. Annealed uncoated stranded conductor.
  - 2. Insulation:
    - a. PVC insulation with nylon outer jacket.
    - b. Rated  $\geq$  600 volts.
    - c. Green.
  - 3. Minimum size 6 AWG.
- C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.
- D. Bonding Conductor Sizing
  - 1. All Communications bonding system conductors shall be sized by length as follows:

Length Linear ft (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

2. The BCT shall be the same size as the TBB or larger.

## 2.2 BONDING CONNECTORS

### A. Acceptable Types:

1. Two-hole compression lug
2. Exothermic weld
3. Irreversible compression

B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.

C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

## 2.3 GROUNDING BUSBAR (TMGB AND TGB)

### A. Features:

1. Wall-mount configuration.
2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
4. Predrilled holes.
5. Integral insulators.
6. Stainless steel offset mounting brackets.

### B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.
  - a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
  - a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.
  - b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers,

paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.

2. A licensed electrician shall perform all bonding.
3. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Main Cross Connect and Service Entrance Room Bonding Requirements:

1. Locate the TMGB in the service entrance room unless otherwise noted on the drawings.
2. The location of the TMGB shall be the shortest practical distance from the telecommunications primary lightning protection devices.
3. Bond the telecommunications primary protectors to the TMGB. Maintain a minimum 1 foot (300 mm) separation of the bonding conductor from all DC power cables, switchboard cable, and high frequency cable.

C. Telecommunications Main Ground Bar (TMGB) Requirements:

1. Install TMGB such that it is insulated from its support with a minimum 2" standoff.
2. Bond the TMGB to the electrical service ground via the BCT.
  - a. A minimum of 1 foot (300 mm) separation shall be maintained between the BCT and any DC power cables, switchboard cable, or high frequency cables.
3. TMGB shall be bonded to all electrical panels located in the same room or space as the TMGB or in an immediately adjacent space within 20 linear feet of the TMGB. TMGB shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TMGB.
4. TMGB shall be bonded to accessible metallic building structure located within the same room or space as the TMGB.
5. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TMGB, shall be bonded to the TMGB.
6. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TMGB, shall be bonded to the TMGB.

D. Telecommunications Ground Bar (TGB) Requirements:

1. Provide a TGB in each telecommunications equipment room.
2. Install TGB such that it is insulated from its support with a minimum 2" standoff.

3. Bond each TGB to the TMGB via the TBB.
    - a. A minimum of 1 foot (300 mm) separation shall be maintained between the TBB and any DC power cables, switchboard cable, or high frequency cables.
    - b. The TBB may be routed from TGB to TGB or as a radial feed to each TGB as the layout requires.
  4. When there are multiple telecommunications equipment rooms on each floor in buildings containing more than five stories, the TGBs on the same floor shall be bonded together horizontally using a grounding equalizer (GE) on the first, last, and every third intermediate floor. GE conductors shall be the same size as the TBB.
  5. If more than one (1) TGB is provided within the same room or space, they shall all be bonded together via a BC the same size as the TBB.
  6. TGBs shall be bonded to accessible metallic building structure located within the same room or space as the TGBs.
  7. TGBs shall be bonded to all electrical panels located in the same room or space as the TGB or in an immediately adjacent space within 20 linear feet of the TGB. TGBs shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TGB.
  8. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TGB, shall be bonded to the TGB.
  9. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TGB, shall be bonded to the TGB.
- E. Metallic Interior Communication Pathway Bonding Requirements:
1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, cable tray, basket tray, and ladder rack, shall be bonded to the communications bonding system.
- F. Bonding Conductor Requirements:
1. Bonding conductors shall be green or marked with a distinctive green color.
  2. Bonding conductors shall be routed parallel and perpendicular to building structure along shortest and straightest paths possible. Number of bends and changes in direction should be minimized. Install and secure conductors in a manner that protects the conductors from impact and from physical or mechanical strain or damage.
  3. Bonding conductors shall not be installed in metallic conduit.
  4. All conductors, including, but not limited, to the BCT, TBB, GE(s), and BC(s), shall be installed splice-free. If the Contractor believes that site conditions do not

allow a splice-free installation, the Contractor may request permission from the Architect/Engineer to splice a specific communications bonding system conductor.

- a. Where documented permission to splice a conductor is granted:
    - 1) The number of splices shall be limited to as few as possible.
    - 2) Splices shall be made using exothermic welding or irreversible compression-type connections only. Splice hardware shall be listed for grounding and bonding. Solder is not an acceptable means of splicing conductors.
    - 3) Splices shall be made in telecommunications spaces in accessible locations to facilitate future inspection and maintenance.
    - 4) Splices shall be adequately supported and protected from impact and from physical or mechanical strain or damage.
  5. All bonding conductors shall be labeled in accordance with the requirements of Section 27 05 53. In addition to the requirements of Section 27 05 53:
    - a. Labels shall be nonmetallic.
    - b. Labels shall be printer-generated.
    - c. Labels shall be located on conductors as close as is practical to their point of termination in a readable position.
    - d. Additionally, conductors shall be labeled as follows:
      - 1) "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER."
  6. Interior water piping is not acceptable for use as a communications bonding system bonding conductor.
  7. Metallic cable shields are not acceptable for use as communications bonding system bonding conductors.
- G. Bonding Connection Requirements:
1. Make all connections in accessible locations to facilitate future inspection and maintenance.
  2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.
  3. Thoroughly clean conductors before installing lugs and connectors.



4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.
5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.
6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer's recommendations and instructions.
7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

### 3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed under provisions of Section 27 05 00.
- B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.
- C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

### 3.3 ADJUSTING

- A. Adjust work under provisions of Section 27 05 00.
- B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

### 3.4 TESTING

- A. Test installed system under provisions of Section 27 17 10.
- B. Measure and document resistance to ground at TMGB, each TGB, each RTGB, and each electrical distribution panel bonded to the TMGB or a TGB.
  1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
  2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms.

3. Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.
- C. Include measurement documentation in test data submitted at completion of project under provisions of Section 27 17 10.

### 3.5 SYSTEM TRAINING

- A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.
1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.
  2. The Architect/Engineer shall be presented with the option to attend the training.
  3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.
- B. At a minimum, the following training shall be conducted:
1. A course detailing the system functions and operations that a technical user will encounter. Provide training on all aspects of using the system, including making new bonding connections to the TMGB, TGB, or RTGB. Provide training on all recommended inspection, maintenance, and repair procedures for the system.
- C. Minimum on-site training times shall be:
1. Technical user: Two (2) hours.

**END OF SECTION 27 05 26**

## SECTION 27 05 28 - INTERIOR COMMUNICATION PATHWAYS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete support systems, conduits, sleeves, innerduct, etc. for an interior cabling plant as shown on the drawings.

#### 1.2 RELATED WORK

- A. Section 26 05 33 - Conduit
- B. Section 27 05 00 - Basic Communications Systems Requirements
- C. Section 27 05 26 - Communications Bonding

#### 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for requirements.

#### 1.4 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

#### 1.5 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.
- B. Coordination Drawings:
  - 1. Include cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

#### 1.6 DRAWINGS

- A. The drawings, which constitute a part of these specifications, indicate the general route of the support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

### PART 2 - PRODUCTS

#### 2.1 CONDUIT

- A. Refer to Section 26 05 33 for conduit requirements for this project.

## 2.2 CABLE HANGERS AND SUPPORTS

- A. Provide a non-continuous cable support system suitable for use with open cable.
- B. Cable Hooks:
  - 1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
  - 2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
  - 3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use.
- C. Cable Hangers:
  - 1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
  - 2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
  - 3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.
  - 4. Cabling hanger load limit shall be 100 lbs per foot.
  - 5. Manufacturer: Erico Caddy, CableCat CAT425, Arlington Fittings TI Series or approved equal.

## 2.3 INNERDUCT – CORRUGATED

- A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.
- B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.
- C. Solvent-cement type joints as recommended by manufacturer.
- D. Inside diameter not less than that of rigid steel conduit.
- E. Dielectric strength a minimum of 400 volts per mil.
- F. Corrugated wall construction.
- G. Pull rope pre-installed by manufacturer.
- H. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all of the above General requirements plus:
  - 1. Be fabricated of flame-retardant materials (plenum rated) suitable for installation in such environments.
  - 2. Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).

- I. Innerduct installed within building riser shafts shall meet all of the above general requirements plus:
  - 1. Be fabricated of flame-retardant materials suitable for installation in such environment.
- J. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

### PART 3 - EXECUTION

#### 3.1 INNER DUCT INSTALLATION REQUIREMENTS

- A. Inner duct shall be riser or plenum rated as required by the installation environment. At minimum, inner duct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.
- B. All exposed inner duct is to be labeled at 35-foot (10 meter minimum) intervals with tags indicating ownership, the cable type (e.g., "Fiber Optic Cable") and the cables it contains (e.g., MA-CS or FS-CS).
- C. Where exposed, fiber optic cable shall be installed in protective inner duct.
- D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation and to ensure that the mechanical limitations, including minimum bend radius of the cable, are considered.
- E. The inner duct should extend into the termination enclosure at system endpoints.
- F. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

#### 3.2 CABLE HOOK SUPPORT SYSTEM

- A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.
- B. Refer to manufacturer's requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.
- C. Cable hooks shall be securely mounted per manufacturer's instructions. In no case shall the side-to-side travel of any cable hook exceed 6".
- D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.
- E. Support spans shall be based on the manufacturer's load ratings. In no case shall a 5 foot span be exceeded.
- F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.

- G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

### 3.3 CONDUIT AND CABLE ROUTING

- A. Refer to specification section 26 05 03 for additional requirements.
- B. All conduits shall be reamed and shall be installed with a nylon bushing.
- C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.
- D. No conduit or sleeve containing more than two (2) cables shall exceed 40% fill ratio, regardless of length.
- E. Any conduit exceeding 90' in length or containing more than three (3) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.
  - 1. A separate pull box is required for each 90' (or greater) length section.
  - 2. A separate pull box is required after any three (3) consecutive 90-degree bends.
  - 3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.
- F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.
- G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

### 3.4 ATTACHMENT TO METAL DECKING

- A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center. This 25 lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

**END OF SECTION 27 05 28**

## **SECTION 27 05 53 - IDENTIFICATION AND ADMINISTRATION**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This section describes the execution and administration requirements relating to the structured cabling system and its termination components and related subsystems.
- B. Identification and labeling.

#### **1.2 RELATED WORK**

- A. Section 27 05 00 – Basic Communications Systems Requirements

#### **1.3 QUALITY ASSURANCE**

- A. Refer to section 27 05 00 for relevant standards.

#### **1.4 SUBMITTALS**

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Documentation of labeling scheme.

### **PART 2 - PRODUCTS**

#### **2.1 ADMINISTRATION**

- A. Administrative requirements include identifiers, records, record linkages and labeling for the purposes of administering building cabling, pathways and spaces and grounding/bonding within a facility.
- B. The administrative system shall be developed in Microsoft Word format or other electronics program approved by the Architect/Engineer. Should the Contractor elect to provide documentation of the administrative system in a proprietary format, the owner shall be provided with a retail licensed version of the software by the Contractor allowing the full editing and reading the documentation.
- C. Refer to the Administrative System Outline below for minimum requirements.
- D. Identifiers:
  - 1. Identifiers shall be marked at the equipment to be administered.
  - 2. Identifiers shall be unique for each type of equipment. For example, in no case shall the identifier for a cable be the same as the identifier for a pathway.
- E. Records:
  - 1. Provides descriptive information about the identified equipment.

F. Linkages:

1. To be used to describe the connection between an identifier and a record. In addition, a linkage is used to point from one record to another record.

G. Presentation of Administrative System:

1. Provide reports cataloging the records for all equipment.
2. Sample reports shall be provided to show explanations of the meaning of all information in the record.
3. Provide reports showing the labeling scheme for all components of the Administrative system.

H. Administrative System Outline:

The format of the outline is as follows:

1. Subsystem:
  - a. Required identifiers
    - 1) Linked records.
2. Pathways:
  - a. Pathway identifier, type, fill, loading.
    - 1) Cable records, space records, pathway records, grounding records.
3. Spaces:
  - a. Space identifier, space type
    - 1) Pathway records, cable records, grounding records.
4. Cable:
  - a. Cable identifier, cable type, total pair count, damaged pair count, unterminated pair count.
    - 1) Termination records, splice records, pathway records, grounding records.
5. Cabling Termination Hardware:
  - a. Termination identifier, hardware type, damaged position numbers.
    - 1) Termination position records, space records, grounding records.
6. Termination Position:
  - a. Termination position identifier, termination type.
    - 1) Cable records, termination hardware records, space records.



7. Splice:
  - a. Splice identifier, splice type
    - 1) Cable records, space records.
8. Telecommunications Main Ground Bar:
  - a. TMGB identifier, busbar type, grounding conductor identifier
    - 1) Bonding conductor records, space records.
9. Bonding Conductors:
  - a. Bonding conductor identifier, conductor type, busbar identifier
    - 1) Grounding busbar records, pathway records.
10. Telecommunications Ground Bar:
  - a. TGB identifier, busbar type
    - 1) Bonding conductor records, space records.

## 2.2 LABELING

- A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.
- B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.
- C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface and attachment method.
- D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.
  1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum "quiet zone" of 0.25" on each side of the bar code.
  2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.
- E. Color Code: Observe the following requirements for color coding:
  1. Labels on each end of a cable shall be the same color for each termination.
  2. Labels for cross-connects shall be two different colors at each termination fields, representative of the color of that field.
  3. Orange (Pantone 15C) shall be used for the demarcation point.
  4. Green (Pantone 353C) shall be used for the termination point of network connection on the facility side of the demarc.

5. Purple (Pantone 264C) shall be used to identify the termination of cables from common equipment (PBX, computers, LANS, etc.)
  6. White shall be used to identify the first-level backbone termination in the main cross-connect.
  7. Gray (Pantone 422C) shall be used to identify the second-level backbone termination in the main cross-connect.
  8. Blue (Pantone 291C) shall be used to identify the termination of station cabling at the telecommunications closet and/or equipment room end of the cable.
  9. Brown (Pantone 465C) shall be used to identify the termination of the interbuilding backbone cable terminations.
  10. Yellow (Pantone 101C) shall be used to identify the termination of auxiliary circuits, alarms, maintenance, security, etc.
  11. Red (Pantone 184C) shall be used to identify the termination of key telephone systems.
  12. In facilities that do not contain a main cross-connect, the color white may be used to identify second-level backbone terminations.
- F. Tag all CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the existing JJC Campus labeling system:
1. Coordinate with JJC for exact scheme and submit a sample for approval.

## PART 3 - EXECUTION

### 3.1 IDENTIFICATION AND LABELING

- A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.
1. Provide additional cable labeling at each manhole and pull box.
  2. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.
  3. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.
- B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.
- C. Termination Hardware Labeling:
1. An identifier shall be provided at each termination hardware location or its label.
- D. Grounding/Bonding Labeling:
1. The TMGB shall be labeled "TMGB." There shall be only one TMGB in the facility.

2. Label all TBB conductors connecting to the TMGB with a unique label, located at both ends of the TBB.
3. Each TGB shall be labeled with a unique label.
4. All TBB conductors connecting to the TGB shall be labeled uniquely at each end of the cable.

**END OF SECTION 27 05 53**



## SECTION 27 11 00 - COMMUNICATION EQUIPMENT ROOMS (CER)

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements related to furnishing and installing equipment for Communication Equipment Rooms. Communication Equipment Rooms include rooms for the Main Cross Connect (MC), Intermediate Cross Connect (IC), Horizontal Cross Connect (HC), Service Entrance Room (SER) and Equipment Room (ER) (such as data centers and main computer rooms housing servers, mainframes and other central equipment).
- B. Definitions:
  - 1. Main Cross Connect (MC): Allows single point administration of technology components for cross-connect of first level backbone cables, entrance cables and equipment cables.
  - 2. Intermediate Cross Connect (IC): Cross connect location between a backbone cable extending from the main cross connect (first level backbone) and the backbone cable from the horizontal cross connect (second level backbone).
  - 3. Horizontal Cross Connect (HC): Cross connect location between the horizontal cabling and the backbone cabling.
  - 4. Service Entrance Room: Accommodates a single location for incoming services to terminate and indicates an interface point and division of responsibility between the building cabling system and the service provider (herein referred to as the demarc).
- C. Refer to Specification Section 27 05 28 for cable pathway and support requirements.

#### 1.2 RELATED WORK

- A. Section 27 05 00 - Basic Communications Systems Requirements
- B. Section 27 05 26 - Communications Bonding
- C. Section 27 05 28 - Interior Communication Pathways
- D. Section 27 15 00 - Horizontal Cabling Requirements

#### 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for applicable standards.

#### 1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.

B. Coordination Drawings:

1. Include ladder racking, equipment racks and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT GROUNDING

- A. Refer to specification section 27 05 26 for grounding requirements.
- B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.2 EQUIPMENT RACKS AND CABINETS

- A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.
- B. The equipment rack shall conform to the following requirements:
  1. Standard TIA/EIA 19" Floor Rack:
    - a. Equipment rack shall be 84" in height, self-supporting and provide a useable mounting height of 45 rack units (RU) (1 RU = 1 ¾").
    - b. Channel uprights shall be spaced to accommodate industry standard 19" mounting.
    - c. Equipment rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
    - d. Equipment racks shall be provided with a supply of spare screws (minimum of 24).
    - e. Equipment racks shall be provided with a ground bar and #6 AWG ground lug.
    - f. Provide all mounting hardware and accessories as required for a complete installation.

## 2.3 CABLE MANAGEMENT – VERTICAL AND HORIZONTAL

### A. Equipment Racks:

1. Equipment racks shall be equipped with vertical and horizontal cable management hardware in the form of rings and guides. Racks shall incorporate vertical and horizontal covers, to allow an orderly, hidden, routing of copper, optical fiber, and coax jumpers from the modular patch panels and/or 110-type termination blocks to the customer provided network electronics. Vertical and horizontal cable management hardware shall be as follows:
  - a. Horizontal cable management hardware shall be 16 gauge cold rolled steel construction with six (6) pass-thru holes and seven (7) front-mounted 3.5” steel rod D-rings. Provide with cover designed to conceal and protect cable.
  - b. At a minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of jacks on modular patch panels, and (b) above and below each optical fiber patch panel and (c) each grouping of two rows of F-type connectors on coax patch panels.
  - c. Vertical cable management hardware shall provide for cable routing on front and rear of each rack and be 14” deep x 6” wide (minimum). Where multiple equipment racks are to be installed, this hardware shall be mounted between the uprights of adjacent equipment racks. Equipment rack uprights and the spacers shall be secured together per manufacturer’s recommendations. Provide with cover designed to conceal and protect cable.
2. Each equipment rack shall be supplied with a minimum of 12 releasable (e.g., “hook and loop”) cable support ties.
3. Where cable termination hardware is wall-mounted, the Contractor shall be responsible for establishing a cable pathway for jumpers routed from the equipment rack(s) to the wall. This shall be in the form of slotted ducts or troughs. Routing of jumpers via the overhead cable tray or ladder rack system is NOT acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Architect/Engineer prior to installation.

## 2.4 PATCH PANELS

- A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.
- B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 27 15 00.
- C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.

- D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.
- E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

## 2.5 OPTICAL FIBER PANELS

- A. All terminated optical fibers shall be mated to simplex LC-type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted. Refer to Section 27 15 00 for coupling requirements.
- B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.
- C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.
- D. Access to the inside of the fiber distribution cabinet's enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.
- E. The fiber distribution cabinet's enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer's recommended minimums or ½", whichever is larger.
- F. All fiber distribution cabinets shall provide protection to both the "facilities" and "user" side of the coupling. The fiber distribution cabinet's enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet's enclosure shall provide a physical barrier to access such optical fiber cables.
- G. Where "Loose Buffered" cables are installed, the 250 µm coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtailed") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar™) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 µm coated optical fibers shall not be permitted.



- H. Fiber distribution cabinets for horizontal cabling: Where optical fiber horizontal cabling is to be terminated, the enclosure shall be compliant to all of the above requirements plus the enclosure shall incorporate a storage mechanism designed to allow simplified identification, access to and termination of individual optical fibers. This may be in the form of a storage cassette, tray or other appropriate mechanism.

## 2.6 LADDER RACK

- A. Provide complete ladder rack system including metallic ladder rack, splice connectors, fastening hardware and other miscellaneous materials as required for a complete installation per manufacturer's recommendations.
- B. Steel C-Channel Stringer Style Ladder Rack:
  - 1. Rolled steel siderail stringer, 2" stringer height, 9" spaced welded rungs.
  - 2. Steel shall meet the requirements of ASTM A1011 SS Grade 33.
  - 3. Loading limits shall be 292 lbs/ft for 4 ft spans.
- C. Ladder rack finish shall be flat black powder coat.

## 2.7 D-RINGS

- A. Rounded edge D-rings for support of cabling in vertical and horizontal configurations.
- B. EIA 310D compliant, manufactured from materials meeting UL94-V0 specifications.
- C. Provide ¼" screw holes for wall mounting.

## 2.8 COPPER PATCH CORDS

- A. Modular Patch Panel:
  - 1. Provide Category 6 Enhanced copper patch cords for 100% of all assigned ports on the modular patch panel. These cords shall be 1' in length. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.
  - 2. Refer to Section 27 15 00 for cable and connector performance requirements.
  - 3. Patch cords shall not be made-up in the field.
  - 4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
    - a. Panduit TX6 Plus Series

## PART 3 - EXECUTION

### 3.1 EQUIPMENT RACKS

- A. Equipment racks shall be furnished and installed as shown on the drawings.
- B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. The rack shall be

stabilized by extending a brace to the wall. Alternately, overhead ladder rack by which the cabling accesses the equipment rack(s) may provide this function.

- C. A space between the rack upright and the wall (approximately 4") should be provided to allow for cabling in that area. The rear of the rack should be approximately 40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Architect/Engineer for resolution prior to installation.
- D. All hardware and equipment is to be mounted between 18" and 79" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware should be reviewed and approved by the Architect/Engineer and Site Coordinator(s) prior to installation.
- E. Equipment racks shall be equipped with cable management hardware as to allow an orderly and secure routing of optical fiber and/or copper cabling to the optical fiber distribution cabinets and/or modular patch panels. At minimum, one such horizontal jumper management panel shall be placed below each optical fiber distribution cabinet installed by the Contractor. Additional Jumper Management panels may be required pending installation of other cable types on the equipment rack.
- F. Each rack shall be grounded to the Telecommunications Ground Bar (GND) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket) directly or via an adjacent grounded equipment rack. Refer to grounding requirements below.

### 3.2 LADDER RACK

- A. Provide support for ladder rack on 4 ft centers.
- B. Maintain a 1.5 safety factor on all load limits specified herein.
- C. Ladder rack support shall be by 5/8" diameter threaded rod when ceiling mounted. Ladder rack requiring wall mounting shall utilize accessories supplied by the ladder rack manufacturer specifically for the purpose of wall mounting ladder rack.

### 3.3 D-RINGS

- A. Provide D-rings for cable routing and management in all areas where open cabling is routed along the wall in an Equipment Room.
- B. Locate D-rings on 24" centers vertically and horizontally.
- C. Securely attach D-rings to the wall as required by the manufacturer.

### 3.4 GROUNDING

- A. Provide a complete grounding system in accordance with the requirements of Section 27 05 26.

### 3.5 CROSS CONNECT INSTALLATION

- A. Bend radius of cable shall not exceed 4 times the outside cable diameter or manufacturer's recommendation, whichever is less.

- B. Cables shall be neatly bundled and dressed to their respective panels and/or blocks. Each shall be fed by an individual bundle separated and dressed to the point of cable entrance into the rack and/or frame.
- C. The cable jacket shall be maintained as close as possible to the termination point.
- D. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that is visible without removing the bundle support.

### 3.6 OPTICAL FIBER TERMINATION

- A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.
- B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.
- C. Each cable shall be clearly labeled at the entrance to all enclosures.
- D. A maximum of 12 strands shall be spliced in any tray.

### 3.7 CONDUITS AND CABLE ROUTING

- A. Refer to Section 26 05 33 for additional requirements.
- B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab.
- C. Where cabling rises vertically in a telecommunications rooms, provide vertical cable management to support the cabling from floor to ceiling level.
- D. All conduits shall be reamed and shall be installed with a nylon bushing.
- E. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

**END OF SECTION 27 11 00**



## SECTION 27 13 00 - BACKBONE CABLING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing backbone communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of both optical fiber and/or copper cabling.

#### 1.2 RELATED WORK

- A. Section 27 05 00 – Basic Technology Systems Requirements.
- B. Section 27 15 00 - Horizontal Cabling Requirements.
- C. Section 27 17 20 - Support and Warranty.

#### 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.

#### 1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.

### PART 2 - PRODUCTS

- 2.1 The basis of design is listed herein. Refer to Section 27 17 20 for additional acceptable manufacturers.

#### 2.2 OPTICAL FIBER BACKBONE – INSIDE PLANT (RISER)

- A. Singlemode (SM):
  - 1. This optical fiber backbone cable shall be suitable for installation in building riser systems, in conduit, in cable tray and/or in innerduct.
  - 2. Optical fiber cable materials shall be all dielectric (no conductive material).
  - 3. Optical fiber cable shall carry an OFNP (Optical Fiber Non-Conductive Plenum) rating.
  - 4. Outer Sheath: The outer sheath shall be marked with the manufacturer's name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.

5. Temperature Range:
    - a. Storage: -40°C to +70°C (no irreversible change in attenuation).
    - b. Operating: -40°C to +70°C.
  6. Humidity Range: 0% to 100%.
  7. Maximum Tensile Strength ( $\geq$  12 fibers):
    - a. During Installation: 1332 Newton (300 lb. force) (no irreversible change in attenuation).
    - b. Long-Term: 600 N (135 lb. force).
  8. Maximum Tensile Strength ( $\leq$  6 fibers):
    - a. During Installation: 1000 Newton (225 lb. force) (no irreversible change in attenuation).
    - b. Long-Term: 100 N (67 lb. force).
  9. Bending Radius:
    - a. During Installation: 20 times cable diameter.
    - b. No Load: 10 times cable diameter.
- B. Optical fiber cables suitable for installation in multiple environments (e.g., underground duct and building risers) may be used at the Contractor's option. Such optical fiber cables shall meet all specifications noted above for cables designated for each environment through which the optical fiber cable shall pass.
- C. Basis of Design (Singlemode):
1. Superior Essex (440xxxx) series plenum.
- D. RG11 Cable – Broadband Coaxial Cable:
1. Basic Construction:
    - a. Center conductor: 14 AWG bare copper covered steel; 0.064" OD (nominal); foamed polyethylene dielectric.
    - b. Four Layer Shield:
      - 1) Innershield: Aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
      - 2) Second shield: 60% 34 AWG bare aluminum braid wire.
      - 3) Third shield: non-bonded aluminum foil tape.
      - 4) Outer shield: 40% 34 AWG bare aluminum braid wire.
    - c. Outer jacket: plenum rated.
    - d. Impedance: 75 ohms.
    - e. Velocity of propagation: 83%.

- f. Maximum attenuation (per 100 feet):
  - 1) at 55-MHz: 0.97 dB.
  - 2) at 450-MHz: 2.65 dB.
  - 3) at 750-MHz: 3.50 dB.
  - 4) at 1000-MHz: 4.23 dB.

2. Acceptable Manufacturers:

- a. Belden 1153A plenum.
- b. Superior Essex.
- c. West Penn.

2.3 OPTICAL FIBER BACKBONE – OUTSIDE PLANT

A. Duct Bank (Multimode/Singlemode):

- 1. This optical fiber cable shall be suitable for installation in underground duct and in innerduct.
- 2. Optical fiber cable materials shall be all dielectric (no conductive materials).
- 3. Optical fiber cable shall be filled with a water-blocking material.
- 4. Outer Sheath: Polyethylene (PE). The outer sheath shall be marked with the manufacturer's name, words identifying the cable type (e.g., "Optical Fiber Cable" or "Fiber Optic Cable"), year of manufacture, and sequential length markings. The actual length of the optical fiber cable shall be within -0/+1% of the length markings. The marking shall be in a contrasting color to the cable jacket.
- 5. Temperature Range:
  - a. Storage: -40°C to +70°C (no irreversible change in attenuation).
  - b. Operating: -40°C to +70°C.
- 6. Humidity Range: 0% to 100%.
- 7. Maximum Tensile Strength:
  - a. During Installation: 2700 Newton (600 lb. force) (no irreversible change in attenuation).
  - b. Long Term: 890 N (200 lb. force).
- 8. Bending Radius:
  - a. During Installation: 20 times cable diameter.
  - b. No Load: 10 times cable diameter.

B. Basis of Design (Singlemode):

- 1. Superior Essex W4012K101 Indoor/Outdoor Plenum Rated

## 2.4 OPTICAL FIBER BACKBONE PERFORMANCE

### A. Singlemode (SM):

1. Fiber Type: Singlemode; doped silica core surrounded by a concentric glass cladding.
2. Core Diameter: 8 to 9  $\mu\text{m}$ . All optical fibers shall be of the same nominal core diameter and profile.
3. Cladding Diameter:  $125 \pm 1.0\mu\text{m}$ .
4. Cladding Non-circularity:  $\leq 1\%$ .
5. Core to Cladding Offset:  $\leq 0.8 \mu\text{m}$ .
6. Fiber Coating Diameter:
  - a.  $245 \pm 15\mu\text{m}$  (primary coating).
  - b. 900-nm (nominal) secondary coating (tight buffer).
  - c. All coatings shall be mechanically strippable without damaging the optical fiber.
7. Cut-off Wavelength (cabled fiber;  $\lambda_{ccf}$ )  $\leq 1260\text{-nm}$ .
8. Mode Field Diameter: 8.3 to 9.8  $\mu\text{m}$  at 1300-nm;  $10.5 \pm 1.0 \mu\text{m}$  at 1550-nm.
9. Zero Dispersion Wavelength ( $\lambda_0$ ):  $1301.5 \text{ nm} \leq \lambda_0 \leq 1321.5 \text{ nm}$ .
10. Zero Dispersion Slope ( $S_0$ ):  $\leq 0.092 \text{ ps/nm}^2\cdot\text{km}$ .
11. Fiber Attenuation (maximum @  $23 \pm 5^\circ\text{C}$ ; Backbone):
  - a. @ 1300-nm: 2.0 dB/km
  - b. @ 1550-nm: 1.75 dB/km

When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation over the rated temperature range of the optical fiber cable shall not exceed 0.05 dB/km at 1550-nm. The magnitude of the maximum attenuation change of each individual optical fiber shall not be greater than 0.15 dB/km at 1550-nm.
12. Fiber Dispersion (maximum):
  - a. @ 1285 to 1330-nm: 3.2-ps/nm\*km
  - b. @ 1550-nm: 18-ps/nm\*km
13. No optical fiber shall show a point discontinuity greater than 0.1 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.



## PART 3 - EXECUTION

### 3.1 CABLE INSTALLATION REQUIREMENTS

- A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.
- B. A minimum of 5 meters (approximately 15 feet) of slack cable (each cable if applicable) shall be coiled and secured at both ends located in the entrance room, Telecommunications Room or main equipment room, for backbone and intra-building cable.
- C. Where exposed, all backbone fiber optic cable shall be installed in protective inner duct. This includes areas where the cable is routed in cable tray and where making a transition between paths (e.g., between conduit and cable tray or into equipment racks). The inner duct should extend into the termination and/or storage enclosure(s) at system endpoints.

### 3.2 CROSS-CONNECTS

- A. The Owner will be responsible for all cross-connects between the data backbone cabling and network electronics and between the data network electronics and horizontal cabling.

**END OF SECTION 27 13 00**



## SECTION 27 15 00 - HORIZONTAL CABLING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper and fiber optic cabling.

#### 1.2 RELATED WORK

- A. Section 27 05 00 - Basic Communications Systems Requirements

#### 1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for relevant standards.
- B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).
- C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.
- D. The installing contractor must be certified by the manufacturer of the structured cabling system.

#### 1.4 SUBMITTALS

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:
  - 1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
  - 2. Manufacturer's installation instructions.

### PART 2 - PRODUCTS

#### 2.1 HORIZONTAL CABLE

- A. CAT 6 Enhanced Plenum Cable:
  - 1. The horizontal cable requirements must be met as well as the following channel requirements.
  - 2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.
  - 3. Performance Tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.

4. Performance data shall be characterized as “Guaranteed Headroom” and shall be warranted by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.
5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 17 20 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.
6. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

<b>Electrical Value (1 - 250 MHz)</b>	<b>Over Standard</b>
Insertion Loss:	3.0%
NEXT:	4.0 dB
PS NEXT:	5.0 dB
ELFEXT	4.0 dB
PS ELFEXT:	5.0 dB
Return Loss:	2.0 dB

7. The jacket color for CAT 6 cable shall be white for all applications.
8. Basis of Design:
  - a. Panduit PUP6504xx-UY CMP

## 2.2 CONNECTORS/COUPLERS/ADAPTERS

- A. Optical Fiber Connectors (LC-type) (Singlemode):
  1. LC-type Optical Fiber Connectors: Shall be used to terminate optical fiber in communication equipment rooms.
  2. LC-type optical fiber connector plugs shall be snap-type with an integrated pull-proof design.
  3. LC-type optical fiber connector plugs shall incorporate a zirconium ceramic ferrule and shall utilize a factory pre-polish end face to ensure fiber-to-fiber physical contact for low loss and reflections.
  4. LC-type optical fiber connector plugs shall accept 1.6mm – 2.0mm and 3.0mm outside diameter fiber.
  5. The average insertion loss is 0.3db for multimode and single mode connectors.

6. LC-type optical fiber connector plugs shall meet the following performance criteria:

<u>Test Procedure</u>	<u>Maximum Attenuation Change</u>
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

7. Additional Performance Requirements:
  - a. Length: 2.23 inches
  - b. Operating Temperature: -40 to 85 degrees C

8. Basis of Design:
  - a. Panduit LC Series

B. Optical Fiber Couplings (LC-type) (Singlemode):

1. LC-type optical fiber couplings shall be used to terminate optical fiber backbone cable on fiber distribution cabinet panels in communication equipment rooms. Horizontal optical fiber cables shall also be terminated using optical fiber couplings at their designated work area locations on information outlet faceplates for "fiber to the desk."
2. LC-type optical fiber couplings shall be snap-type with locking washer and nut.
3. LC-type optical fiber couplings shall incorporate domed zirconia ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.
4. LC-type optical fiber couplings shall accept 125-micron outside diameter multimode fiber.
5. The attenuation per mated pair shall not exceed 0.7 dB (individual) and 0.5 dB (average). Connectors shall sustain a minimum of 200 mating cycles per TIA/EIA-455-21 without violating specifications.
6. SC-type optical fiber couplings shall meet the following performance criteria:

<u>Test Procedure</u>	<u>Maximum Attenuation Change</u>
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

7. Additional Performance Requirements:
  - a. Length: 2 inches (5.08cm)
  - b. Operating Temperature: -40 to 85 degrees C
8. Basis of Design:
  - a. Panduit FAP6WBUDLCZ

C. Coax (F-Connector):

1. RG-6 and RG-11 coax cable shall be terminated at the work area and at communication equipment rooms in a male F-type connector.
2. The male F-type connector shall:
  - a. Be matched to the RG-6 and RG-11 coax cable type proposed by the Contractor.
  - b. Be a single-piece F-type connector.
  - c. Incorporate a 1/2" crimp ring which uses hex crimp.
3. The male F-type connectors shall be mated to female/female feed-thru couplings at both the information outlet and modular patch panel locations. These couplings shall be matched to the male F-type connector. Couplings shall be of sufficient length as to allow for the male F-type connector to fully seat (both sides).

2.3 FACEPLATES/JACKS

A. CAT 6 Jacks:

1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
6. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall (1) match the faceplate color used for other utilities in the building or (2) when installed in surface raceway (if applicable), match the color of that raceway.
7. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
  - a. Be a low-profile assembly.

- b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.
  - c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.
  - d. Incorporate a shroud that protects the optical fiber couplings from impact damage.
8. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.
  9. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.
  10. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.
  11. CAT 6 modular jacks shall be pinned per TIA-568B.
  12. CAT 6 termination hardware shall, as a minimum, meet all of the mechanical and electrical performance requirements of the following standards:
    - a. ANSI/TIA/EIA-568-A-5
    - b. ANSI/TIA/EIA-568A
    - c. ISO/IEC 11801
    - d. IEC 603-7
    - e. FCC PART 68 SUBPART F
  13. The color for CAT 6 jacks shall be white for all applications.

## 2.4 RG-11 BROADBAND RF COAXIAL CABLE

### A. Basic Construction:

1. Center conductor: 14 AWG bare copper covered steel; 0.064" O.D. (nominal); foamed polyethylene dielectric.
2. Four Layer Shield:
  - a. Inner shield: aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
  - b. Second shield: 60% 34 AWG bare aluminum braid wire.
  - c. Third shield: non-bonded aluminum foil tape.
  - d. Outer shield: 40% 34 AWG bare aluminum braid wire.
3. Outer jacket: Plenum rated.

### B. Electrical Performance Characteristics:

1. Impedance: 75 ohms.
2. Velocity of propagation:  $\geq 82\%$ .

3. Velocity of propagation:  $\geq 82\%$ .
4. Maximum attenuation (per 100 feet):
  - a. at 55-MHz: 0.97 dB
  - b. at 450-MHz: 2.65 dB
  - c. at 750-MHz: 3.50 dB
  - d. at 1000-MHz: 4.23 dB
5. Maximum attenuation (per 100 feet):
  - a. at 50-MHz: 1.20 dB
  - b. at 400-MHz: 3.50 dB
  - c. at 700-MHz: 4.60 dB
  - d. at 1000-MHz: 5.60 dB

C. Acceptable Manufacturers:

1. Belden 1617A
2. Belden 1153AP
3. CommScope
4. West Penn
5. Times Fiber

## 2.5 RG-6 BROADBAND RF COAXIAL CABLE

A. Basic Construction:

1. Center conductor: 18 AWG bare copper covered steel; 0.040" O.D. (nominal); foamed polyethylene dielectric.
2. Four Layer Shield:
  - a. Inner shield: aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
  - b. Second shield: 60% 34 AWG bare aluminum braid wire.
  - c. Third shield: non-bonded aluminum foil tape.
  - d. Outer shield: 40% 34 AWG bare aluminum braid wire.
3. Outer jacket: Plenum rated.

B. Electrical Performance Characteristics:

1. Impedance: 75 ohms.
2. Velocity of propagation:  $\geq 82\%$ .
3. Velocity of propagation:  $\geq 82\%$ .



4. Maximum attenuation (per 100 feet):
  - a. at 55-MHz: 1.60 dB
  - b. at 450-MHz: 4.26 dB
  - c. at 750-MHz: 5.59 dB
  - d. at 1000-MHz: 6.54 dB
5. Maximum attenuation (per 100 feet):
  - a. at 50-MHz: 1.60 dB
  - b. at 400-MHz: 4.60 dB
  - c. at 700-MHz: 6.60 dB
  - d. at 1000-MHz: 8.20 dB

C. Acceptable Manufacturers:

1. Belden 1189A
2. Belden 1189AP
3. CommScope
4. West Penn
5. Times Fiber

## 2.6 COPPER WORK AREA CORDS

A. RJ-45:

1. Provide the same quantity of Category 6 copper work area cords as copper patch panel cords specified in Section 27 11 00. Copper work area cords shall be equipped with an 8-pin modular RJ-45 connector on each end.
2. Work area cords shall be 10' in length.
3. Manufacturer of copper patch cable shall be the same as the manufacturer of the horizontal copper cable.

B. RG-6 Broadband RF Coaxial with F-Connectors:

1. Provide one (1) coaxial work area cable for each CATV information outlet location installed.
2. Coaxial work area cables shall consist of quad-shielded RG-6 broadband RF coaxial cable meeting electrical performance characteristics specified earlier in this section, and be equipped with compression-style F-connectors on each end.
3. Work area cords shall be 3 feet in length.

## PART 3 - EXECUTION

### 3.1 CABLE INSTALLATION REQUIREMENTS

A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and

termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.

2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.
3. Manufacturer's minimum bend radius specifications shall be observed in all instances.
4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.
5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.
6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.
7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
8. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
9. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:
  - a. Twelve (12) inches from power lines of <5-kVa.
  - b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
  - c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
  - d. Thirty-nine (39) inches from transformers and motors.
10. Information outlets shown on floor plans with the subscript "W" are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12" vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.

B. Horizontal Cabling in Modular Furniture:

1. This Contractor shall be responsible for providing and installing cable completely to the information outlet in the furniture. This Contractor's responsibility does not end at the furniture feed point.

2. Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via conduit.
3. Where modular furniture is installed without wall contact, the Contractor shall install cabling through floor fittings as shown on the drawings.
4. Cabling shall be protected in the transition from the floor or wall fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the Floor and Wall Fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill ratio (cable area vs. conduit area) in each feed shall not exceed 40%.
5. For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.
6. For purposes of bidding, it is to be assumed that it will be the responsibility of the Contractor to punch and reinstall the bottom molding panels on the modular furniture as required to accommodate the communications cabling and information outlets. The panels shall be marked prior to installation by the Owner to identify the desired location of the information outlets.
7. The information outlet shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the information outlet to the panel shall not result in sharp protrusions (e.g., sheet metal screw tip) into the channel behind the panel.

### 3.2 CABLE TERMINATION REQUIREMENTS

#### A. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.
2. If the "last" patch (per rack) is greater than 50% utilized, one additional patch panel shall be provided for future use.
3. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

#### B. Cable Terminations - Fiber Optic:

1. ALL fibers shall be terminated using the specified connector type.
2. All terminated fibers at the telecommunications rooms shall be mated to couplings mounted on panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.
3. All couplings shall be fitted with a dust cap.

4. Fibers from multiple locations may share a common enclosure, however, they must be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure provided that they are clearly identified as such. Fibers from different locations shall NOT share a common connector panel (e.g., "insert").
  5. Slack in each fiber shall be provided to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1 meter (approximately 39") of slack shall be retained regardless of panel position relative to the potential work area.
- C. Cable Terminations - RG-6 and RG-11 Coax:
1. Directional coupler / taps shall be sized to accommodate an additional 20% growth in the number of cables terminated at any given location. [Unused directional coupler / tap ports shall be terminated with a 75-Ohm F-type terminator.]
  2. All cables shall be terminated in the specified connector type and mated [to female feed-through couplers mounted on the patch panels] [directly to wall-mounted directional coupler / taps]. Coaxial cables shall be dressed neatly [at the rear of the panel and secured to cable management brackets per manufacturer guidelines] [and secured to D-rings per manufacturer guidelines].
  3. When preparing the RG-6 and RG-11 coaxial cable for termination, manufacturer's installation procedures shall be adhered to. Special care shall be taken to ensure the proper center conductor length as specified by the manufacturer.
  4. All coaxial cable connectors shall be mated to the cable using only the appropriate purpose-designed tools recommended by the manufacturer for that purpose.

**END OF SECTION 27 15 00**

## **SECTION 27 17 10 - TESTING**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

#### **1.2 RELATED WORK**

- A. Section 27 05 00 – Basic Communications Systems Requirements

#### **1.3 QUALITY ASSURANCE**

- A. Refer to Section 27 05 00 for relevant standards.

#### **1.4 SUBMITTALS**

- A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work, the Contractor shall submit:
  - 1. Complete information on testing procedure as described herein.

### **PART 2 - PRODUCTS**

#### **2.1 TESTING COPPER**

- A. General Requirements:
  - 1. The Contractor is responsible to perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.
  - 2. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor should provide a summary of the proposed test plan for each cable type including equipment to be used, setup, test frequencies or wavelengths, results format, etc. The method of testing shall be approved by the Architect/Engineer.
  - 3. The Contractor shall visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. The Contractor shall provide the Architect/Engineer with a written certification that this inspection has been made.
  - 4. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
  - 5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.

6. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, the Contractor shall provide copies of the original test results.
7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
  - a. CAT 6 Cable:
    - 1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.
    - 2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
    - 3) CAT 6 horizontal cable shall also be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Basic Link" including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
      - a) Wire Map
      - b) Length
      - c) NEXT Loss (Pair-to-Pair)
      - d) NEXT (Power Sum)
      - e) ELFEXT (Pair-to-Pair)
      - f) ELFEXT (Power Sum)
      - g) Return Loss
      - h) Attenuation
      - i) Propagation Delay
      - j) Delay Skew
    - 4) The maximum length of horizontal cable shall not exceed 295 feet (90m), which allows 33 feet (10 m) for technology equipment and modular patch cords.
    - 5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP

and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.

- 6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify, "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS\*, FAIL\*, or FAIL result for any of the parameters will not be accepted.
- 7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

## 2.2 TESTING FIBER

### A. General Requirements:

1. The Contractor is responsible to perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. The Contractor is responsible for supplying all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor should provide a summary of the proposed test plan for each optical fiber cable type including equipment to be used, setup, test frequencies or wavelengths, results format, etc. The method of testing shall be approved by the Architect/Engineer.
3. The Contractor shall visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. The Contractor shall provide the Architect/Engineer with a written certification that this inspection has been made.
4. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.
6. The Contractor shall provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, the Contractor shall provide copies of the original test results.

7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, the Contractor shall provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
  - a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.
  - b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.
  - c. Tests Prior to Installation:
    - 1) The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. The Contractor shall supply this test data to the Architect/Engineer prior to installation.
  - d. Tests After Installation:
    - 1) Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:
      - a) Optical Attenuation ("Insertion Loss" Method):
        - (1) Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers shall be tested at  $850 \pm 30$  nm. Singlemode optical fibers (if applicable) shall be tested at  $1300 \pm 20$  nm.<sup>7</sup>



- (2) Attenuation of optical fibers shall not exceed the values calculated as follows:

$$\text{Attenuation (max.)} = 2 * C + L * F + S \text{ dB}$$

Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices \* maximum attenuation per splice).

b) Verification of Link Integrity (OTDR):

- (1) All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.
- (2) Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.
- (3) OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

## 2.3 DOCUMENTATION/AS-BUILTS/RECORDS

### A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.
2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.
3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

### B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (CD-ROM). The CD-ROM shall contain the electronic equivalent of the test results as defined by the bid specification and be of a format readable by Microsoft Word (Version 6.0 or newer). The Contractor shall provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. The Contractor shall furnish one (1) copy of the Data and Display (if applicable) software.

### C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).
2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form on CD-ROM for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, the Contractor shall provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a DOS or Microsoft Windows-based personal computer.

### D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

NOT APPLICABLE

**END OF SECTION 27 17 10**



## **SECTION 27 17 20 - SUPPORT AND WARRANTY**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

#### **1.2 RELATED WORK**

- A. Section 27 05 00 – Basic Technology Systems Requirements.

#### **1.3 QUALITY ASSURANCE**

- A. Refer to Section 27 05 00 for relevant standards.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURER REQUIREMENTS**

- A. The Basis of Design for all structured cabling components is listed in the individual Division 27 sections. Alternative acceptable manufacturers will not be accepted for this project.

- 1. Exceptions:

- a. Optical fiber.

- B. Additional acceptable manufacturers for optical fiber:

- 1. Corning

#### **2.2 WARRANTY**

- A. A twenty-five (25) year Product Installation Warranty and System Assurance Warranty shall be provided for the structured cabling system as described in the contract documents.
- B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).
- C. The system assurance warranty shall cover the failure of the wiring system to support the application it was designed to support, as well as additional applications introduced in the future by recognized standards or user forums that use the TIA/EIA 568A component and link/channel specifications for cabling.
- D. Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate from the manufacturing company registering the installation.

PART 3 - EXECUTION

NOT APPLICABLE

**END OF SECTION 27 17 20**

## **SECTION 28 31 00 - FIRE ALARM AND DETECTION SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 WORK INCLUDES**

- A. Fire alarm and detection systems

#### **1.2 QUALITY ASSURANCE**

- A. Installer: A factory-authorized licensed electrical or security contractor with five years experience in the design, installation and maintenance of fire alarm systems by that manufacturer.
- B. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 3. This person's name and certification number shall appear on the start-up and testing reports.

#### **1.3 REFERENCES**

- A. ASME A17.1 - Safety Code for Elevators and Escalators
- B. NFPA 70 - National Electrical Code
- C. NFPA 72 - National Fire Alarm and Signaling Code
- D. NFPA 101 - Life Safety Code
- E. UL 2572 - Control And Communication Units For Mass Notification Systems

#### **1.4 SUBMITTALS**

- A. Submit shop drawings and product data. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.
- B. Provide a product catalog data sheet for each piece of equipment that is required for the operation of the system.
- C. Submit CAD floor plans showing the complete layout of the entire system including device addresses, auxiliary equipment, and manufacturer's wiring requirements. The submitted drawings shall be comprehensive of the entire system and shall include all existing system equipment, devices, etc. Record drawings of the existing system will be furnished upon request.
- D. With regard to all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.
- E. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.
- F. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.

- G. The fire alarm submittal shall have a Professional Engineer's stamp and signature of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.

## 1.5 REGULATORY REQUIREMENTS

- A. System: UL or FM Global listed.
- B. Conform to requirements of NFPA 101.
- C. Conform to requirements of Americans with Disabilities Act (ADA).
- D. Conform to UL 864 Fire Alarm, UL 1076 Security, and UL 2572 Communications.

## 1.6 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, voice evacuation equipment, emergency communication systems, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.
- C. Extending the existing fire alarm system: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to extend the existing fire alarm system. This includes but is not limited to additional power supplies, initiating devices and circuits, signaling devices and circuits, monitoring devices and circuits, auxiliary control and related devices such as, door holders and their control, smoke damper control, fan shutdown, etc. The existing fire alarm system shall be extended such that the existing fire alarm system's functionality, integrity and annunciation shall be equivalent to pre-construction conditions unless noted otherwise. The functionality and integrity shall be maintained during construction. The entire system shall be able to be completely reset from any single reset location point. The entire system shall be annunciated at any annunciation location.
- D. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.
- E. Firefighter Phone System: The existing system has a two-way talk path for the fire department's use from the voice command center to the secondary fire alarm attack entrances, elevator lobbies, primary and backup power rooms and the entrance to all enclosed stairways.
- F. Emergency Communication System (ECS): The existing system is capable of reproduction of prerecorded, synthesized, or live messages with voice intelligibility to indicate the existence of an emergency situation and communicating information necessary to facilitate



an appropriate response and action. The system provides alerting in the building and surrounding exterior.

- G. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.
- H. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.

#### 1.7 PROJECT RECORD DOCUMENTS

- A. Include location of end-of-line devices.
- B. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.
- C. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.

#### 1.8 OPERATION AND MAINTENANCE DATA

- A. Include operating instructions, and maintenance and repair procedures.
- B. Include results of testing of all devices and functions.

#### 1.9 WARRANTY

- A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.
- B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Edwards (EST) - Matching existing system

#### 2.2 FIRE ALARM CONTROL PANEL

- A. Existing Fire Alarm Control Panel is Edwards EST3. Provide all required components, hardware, software, programming, etc. needed to extend the existing fire alarm system.
- B. Provide additional battery capacity as necessary to allow for operation of the entire system for 24 hours in a non-alarm state followed by alarm mode for 15 minutes, plus 25% spare capacity for future devices.

## 2.3 SIGNALING LINE CIRCUIT DEVICES

### A. **[FA-SD]:** Smoke Detectors:

1. Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
2. Each smoke detector shall connect directly to an SLC loop.
3. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.
4. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
5. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.
6. A test means shall be provided to simulate an alarm condition.
7. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.
8. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Recall, DH=Door Hold Release.

### B. **[FA-DSD]:** Duct Smoke Detectors:

1. Duct-type smoke detectors shall use the same analog photoelectric sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
2. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, the Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
3. A "W" subscript on the Drawings denotes a weatherproof device is required.
  - a. Weatherproof device shall be a conventional device with a unique monitor module. All detectors associated with a single HVAC unit's supply may be served by a single monitor module and all detectors associated with a single HVAC unit's return ductwork may be served by a single monitor module. Monitor modules shall be located on the interior of the building near the location of remote indicators noted on the Drawings.
  - b. Detector shall have an operating temperature range of -4° - 158 ° F and humidity range of 0 - 95% non-condensing.
  - c. Enclosure shall be NEMA 4 UL listed for outdoor applications.

- d. Acceptable Manufacturers: System Sensor D4120W or equivalent.
4. **[FA-RI]:** Provide a remote test and alarm LED indicator device. Locate remote indicator as shown on the Drawings or in a location coordinated with the Architect/Engineer. Provide with a single-gang faceplate (color to match switch and receptacle coverplates) labeled: "Duct Smoke Detector" and name of associated HVAC equipment.
- C. **[FA-PS]:** Manual Pull Stations:
1. The stations shall be mounted where shown on the drawings and be provided with all necessary mounting hardware.
  2. Addressable, double action, reset key lock, semi-flush mount, red high abuse plastic or cast metal construction with white lettering.
  3. Manual stations shall connect directly to an SLC loop. Stations shall provide address setting means using rotary decimal or DIP switches.
  4. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location, with maintained temperatures between 32°F and 120°F.
- D. **[FA-HD]:** Heat Detectors:
1. Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135°F and at 15°F per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.
    - a. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Shutdown.
  2. Provide a two-piece head/base design, with a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
  3. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.
  4. Provide a remote LED indicator device if detector is not visible from a floor-standing position.
  5. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. A connection for attachment of a remote indicator shall be provided.
  6. A test means shall be provided to simulate an alarm condition.
  7. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

E. **[FA-MM]:** Monitor Modules:

1. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.
2. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
3. The module shall supply the required power to operate the monitored device(s).
4. The module shall provide address setting means using rotary decimal or DIP switches.

F. **[FA-AR]:** Addressable Relays:

1. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional slave relay(s), as required, rated for the electrical load being controlled (contractor to match voltage, amps, etc.).
2. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
3. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
4. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

2.4 NOTIFICATION APPLIANCE DEVICES

A. Device Color:

1. Wall Mounted: White housing with red "Alert" lettering or pictogram.
2. Ceiling Mounted: White housing with red "Alert" lettering or pictogram.

B. Visual Alarm Devices:

1. **[FA-VW]:** Wall mounted.
2. **[FA-VC]:** Ceiling mounted.
3. High intensity (candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.
  - a. Candela Ratings: V1=15, V3=30, V7=75, VH=110, VS=177.

4. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
  5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
- C. Audio (Speaker) Alarm Devices:
- D. **[FA-AW]:** Wall Mounted.
- E. **[FA-AC]:** Ceiling Mounted Sound rating shall be dependent on the tap (wattage) setting. Tap settings shall be available in 3 dBA increments. A minimum of four (4) tap settings should be available to allow field adjustment of the sound output across a minimum range of 78 to 87 dBA, 400Hz to 4KHz (6 dBA cutoff) frequency range. Speakers shall operate on a 25V RMS system, unless otherwise noted on drawings.
2. Speakers shall clearly reproduce a signal consisting of a live or prerecorded human voice and background music with voice intelligibility.
  3. Speaker, housing, and backbox shall be UL listed for fire alarm/emergency applications.
- F. Combination Audio (Voice) and Visual Notification Device:
1. **[FA-AVW]:** Wall mounted.
  2. **[FA-AVC]:** Ceiling mounted.
  3. Combine speaker and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
  4. A "W" subscript on the Drawings denotes a weatherproof device is required.

## 2.5 NAC EXTENDER PANELS (NEP)

- A. Furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC). Contractor shall indicate quantity and locations of each NEP on the shop drawing submittals.
- B. Each NEP shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NEP provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.
- C. Power for each NEP shall be from a local 120 VAC life safety emergency branch circuit. Provide two #10 conductors and one #10 ground in 3/4" conduit to each NEP from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Coordinate panel and circuit number with Architect/Engineer prior to installation.
- D. NAC extender panels may be installed only in locations coordinated with the Architect/Engineer.

E. Mounting: Surface.

## 2.6 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

A. **[FA-FS]:** Flow Switch:

1. Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface.

B. **[FA-MS]:** Monitor Switch:

1. Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface.

## 2.7 WIRING

A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with NFPA 70, Article 760 for power-limited fire alarm signal service.

B. Approved manufacturers of fire alarm cable:

1. Comtran Corp.
2. Helix/HiTemp Cables, Inc.
3. Rockbestos-Suprenant Cable Corp.
4. West Penn Wire/CDT.

## 2.8 ANNUNCIATORS

A. **[FAA-1]:** Remote LCD Annunciators

1. Auxiliary annunciators shall indicate alarm and trouble conditions visually and audibly as shown on the drawings. Provide local TROUBLE ACKNOWLEDGE, TEST, and ALARM SILENCE capability. Minimum 80-character display.
2. Communications and power to the annunciators shall be supervised. The annunciator shall receive power from the fire alarm control panel.
3. A single key switch shall enable all switches on the annunciator.
4. Remote annunciators shall include selector switches for pre-recorded voice announcements and a microphone for live manual override voice announcements.
5. Mounting: Flush mount with appropriate flange. Architect shall select color.

## PART 3 - EXECUTION

### 3.1 SEQUENCES OF FIRE ALARM OPERATION

#### A. General:

1. Refer to the Fire Alarm Operation Matrix on the drawings for basic requirements and system operation.
2. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

#### B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:

1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel, transponder, and annunciator locations.
2. A local signal in the control panel shall sound.
3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
4. History storage equipment shall log the information associated with the fire alarm control panel (FAP) condition, along with the time and date.
5. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.
6. Transmit the appropriate signal (supervisory, trouble, alarm) to the building automation system.

#### C. Audible Alarms Sequence:

1. Audible alarms throughout the building shall sound.

#### D. Visual Alarms Sequence:

1. Visual alarms throughout the building shall flash.

#### E. AHU Shutdown Sequence:

1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers. Coordinate other requirements with Heating Contractor.
2. The fire alarm system shall directly shut down the AHU through the local HVAC control device (i.e., variable frequency drive or motor starter).
3. Where a facility has more than one AHU, each shall be shutdown individually based on input from initiation devices in the area served by the unit or designated for each AHU.

- F. Elevator Recall Sequence:
1. Elevator recall sequences shall meet the requirements of ASME/ANSI A17.1 and NFPA 72.
  2. Upon signal from a smoke detector in the machine room, hoistway, or any elevator lobby other than the "designated level" the fire alarm shall utilize an addressable relay to signal the elevator to recall to the designated level as determined by the Authority Having Jurisdiction.
  3. Upon signal from a smoke detector in the elevator lobby of the "designated level," the fire alarm system shall utilize an addressable relay to signal the elevator to recall to the "alternate level" as determined by the Authority Having Jurisdiction.
  4. All elevators that share the same hoistway, machine room or lobby shall be recalled simultaneously. Elevators served by different machine rooms, hoistways and lobbies shall continue to operate.
- G. Firefighter's Cab Visual Alarm Sequence:
1. Upon signal from a detector in the machine room or elevator hoistway, the fire alarm system shall utilize an addressable relay to signal the elevator controller to illuminate and flash the firefighters cab visual alarm.
- H. Elevator Shutdown Sequence:
1. Elevator shutdown shall meet the requirements of ASME/ANSI A17.1.
  2. All elevators that share the same hoistway, machine room, or lobby shall be shut down simultaneously. Elevators served by different machine rooms, hoistways, and lobbies shall continue to operate.
  3. The fire alarm system shall utilize an addressable relay to energize the shunt trip of the main elevator breaker, disconnecting power to the elevator.

### 3.2 INSTALLATION

- A. Install system in accordance with manufacturer's instructions and referenced codes.
- B. Devices:
1. General:
    - a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
    - b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
    - c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.



- d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall notify the Architect/Engineer to coordinate a different acceptable location.
  2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.
  3. Analog Smoke and Heat Detectors:
    - a. In elevator shafts and elevator equipment rooms, provide a heat detector for elevator shutdown within 2' of every sprinkler head. Coordinate with fire protection contractor.
  4. Duct-type Analog Smoke Detectors:
    - a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
    - b. All detectors shall be accessible.
    - c. Duct-type detectors shall be installed according to the manufacturer's instructions.
  5. Manual Pull Stations:
    - a. Stations shall be located where shown and at the height noted on the drawings.
  6. Addressable Relays and Monitor Modules:
    - a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.
    - b. All modules shall be mounted in or on a junction box in an accessible location.
  7. Notification Appliance Devices:
    - a. Devices shall be located where shown on the drawings.
- C. Wiring:
  1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
  2. All wiring shall be installed in red-colored conduit.

3. All junction boxes shall be painted red with SLC and NAC circuits identified on cover.
  4. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 26 05 13.
  5. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
    - a. Fire alarm temporal audible notification for all audio appliances.
    - b. Synchronization of all visual devices where two or more devices are visible from the same location.
    - c. Ability to silence audible alarm while maintaining visual device operation.
  6. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.
- D. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device and shall not have visible knockouts.

### 3.3 FIELD QUALITY CONTROL

- A. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.
- B. Contractor shall test and adjust the voice fire alarm system as follows:
  1. Speaker taps shall be adjusted to the lowest tap setting which achieves a sound level higher than the greatest of the following:
    - a. 70dBA.
    - b. 15 dBA above ambient levels as indicated in NFPA 72 Table A.18.4.3.
    - c. 15 dBA above measured ambient. 5 dBA above the maximum measured sound level with duration of more than 60 seconds.
  2. Sound level measurement procedure shall meet the following requirements:
    - a. All measurements shall use the 'A' weighted, dBA, sound measurement scale.
    - b. All measurements shall be taken after furnishings, wall coverings and floor coverings are in place.

- c. All measurements shall be taken after fixed equipment (HVAC units, etc) producing ambient noise is installed and is in operation.
- d. All sound level measurements shall be taken at a height of 5' above the finished floor level.
- e. Measurements shall be taken in every unique room. If there are multiple rooms, which have the identical dimensions and function, 10%, or a minimum of 2 rooms shall be tested. The results from the rooms tested shall be averaged and the remaining rooms may be adjusted per the average.
- f. Measurements shall be taken on a 20' x 20' grid and the results for all points taken shall be averaged. If the room is smaller than 20' x 20' a minimum of two measurements are required.
- g. Measurements shall be taken halfway between speakers or halfway between a speaker and the wall. No measurements shall be taken at the extreme edges of the room, nor directly under speakers.

#### 3.4 MANUFACTURER'S FIELD SERVICES

- A. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.
- B. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Using Agency selects. The Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Using Agency directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.

**END OF SECTION 28 31 00**



## **SECTION 31 11 00 – SITE CLEARING**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes:

- 1. Removal of existing trees.
- 2. Removal of above- and below-grade site improvements.
- 3. Removal of storm sewers and storm structures.
- 4. Temporary erosion and sedimentation control measures.
- 5. Removal of signage and deliver for reuse.
- 6. Removal of electrical & communication lines, light poles, light bases and related electrical and communication appurtenances.
- 7. LEED documentation for certification.

- B. RELATED REQUIREMENTS

- 1. Section 01 57 13 "Temporary Erosion and Sediment Control" for control of storm water runoff.
- 2. Section 02 41 00 "Demolition" for demolition of buildings, structures, and site improvements.
- 3. Section 01 74 13 "Construction Cleaning" for measures to keep the construction site clear of dirt and debris during construction.
- 4. Section 01 74 23 "Final Cleaning" for cleaning the job site after construction.
- 5. Section 31 14 12 "Topsoil Excavation and Placement" for handling of topsoil.
- 6. Section 31 20 00 "Earth Moving" for soil materials, excavating, backfilling, and site grading.
- 7. Section 31 23 13 "Subgrade Preparation" for preparation of soil for pavements.
- 8. Section 32 92 00 "Turf and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

#### **1.3 REFERENCE STANDARDS**

- A. IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015, except where otherwise specified herein.
- B. Storm Water Pollution Prevention Plan (SWPPP)

#### 1.4 ABBREVIATIONS

- A. IEPA Illinois Environmental Protection Agency
- B. IDOT Illinois Department of Transportation
- C. NPDES National Pollution Discharge Elimination System
- D. SWPPP Storm Water Pollution Prevention Plan
- E. NOI Notice of Intent
- F. ION Incidence of Non-Compliance
- G. NOT Notice of Termination

#### 1.5 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain using Agency's property, cleared materials shall become Contractor's property and shall be removed from Project site.

#### 1.6 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings, according to Section 01 78 39 "Project Record Documents", identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.
- C. Contractor/Subcontractor Certification Statements certifying under penalty of law understanding the terms National Pollution Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with activity from the construction site.
- D. Erosion and Sediment Control Inspection Reports.
- E. Copies of NOT form sent to IEPA.

#### 1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from using agency and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on premises as directed by the Construction Manager.

- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

## PART 2 PRODUCTS

### 2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31 20 00 "Earth Moving".
  - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to using agency.
- D. Preserve in operating condition active utilities traversing the project site including mains, tile lines, manholes, catch basins, poles, guys and other appurtenances.
- E. Prior to starting work, establish locations and extent of underground utilities occurring in work area.
- F. Contact Joint Utility Locating Information for Excavators (J.U.L.I.E.). Note: underground utilities within the Joliet Junior College campus are not part of J.U.L.I.E.. The Contractor shall coordinate and pay for all utility locates.
- G. Contractor is responsible for locating and verifying types of materials and sizes of underground utilities as necessary to complete construction activities.

### 3.2 INSTALLATION

- A. Provide adequate protection to persons and protect all property at all times
- B. Execute the work in such a manner as to avoid interference with the use of or passage to and from adjacent buildings or facilities.
- C. Do not use blasting on the Project site.
- D. Do not burn materials or debris on the premises.
- E. Remove existing paving and other site improvements from the site, as required for the new construction and site improvements.

### 3.3 EROSION AND SEDIMENT CONTROL

- A. Follow the SWPPP for the Project.
- B. General Contractor shall sign a copy of the certification statement contained in the SWPPP and maintain a copy of the SWPPP on site at all times.
- C. Submit NOT upon the completion of construction activities.

### 3.4 REMOVAL OF EXISTING PAVEMENT AND APPURTENANCES

- A. In accordance with Articles 440.01 and 440.03 of the IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015.

### 3.5 PROTECTION

- A. Protect benchmarks, control points and existing facilities from damage or displacement.
- B. Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within the drip line, excess foot or vehicular traffic, or parking of vehicles with the drip line. Provide temporary guards to protect trees and vegetation to be left standing.

### 3.6 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be re-located.
  - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
  - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
  - 4. Use only hand methods for grubbing within tree protection zone.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

### 3.7 TOPSOIL STRIPPING

- A. Perform in accordance with Section 31 14 12 "Topsoil Excavation and Placement".



### 3.8 CLEAN AND ADJUST

- A. Remove from the site rubbish and debris found thereon or resulting from the work of demolition. At the completion leave the site in a safe and clean condition, free from materials or equipment.
- B. Repair any active utility damaged due to work under this contract to the satisfaction of the utility company and the Construction Manager.
- C. Repair all inlets, catch basins, storm sewers or sanitary sewers damaged due to work under this contract to the satisfaction of the Construction Manager.
- D. Clean all inlets, catch basins and storm sewers to eliminate any debris.

END OF SECTION 311000



## **SECTION 31 20 00 – EARTH MOVING**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

##### **A. Work Includes:**

1. Preparing subgrades for, walks and pavements.
2. Base course for concrete walks & pavements.
3. Subsurface drainage backfill for trenches.
4. Excavating and backfilling for utility trenches.
5. Excavating and backfilling trenches for storm sewer and storm structures.
6. Excavating and backfilling trenches for electrical and communication lines and appurtenances.

##### **B. Related Requirements:**

1. Section 31 10 00 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements
2. Section 31 23 13 "Subgrade Preparation" for preparation of subgrades beneath pavements.
3. Section 31 23 19 "Dewatering" for lowering and disposing of ground water during construction.
4. Section 32 92 00 "Turf and Grasses" for finish grading, including preparing and placing topsoil and planting soil for lawns.

#### **1.3 REFERENCE STANDARDS**

- A. IDOT Standard Specifications for Road and Bridge Construction, 2015 – Section 202, Earth Rock Excavation. Articles 202.02, 202.03 and 202.05.
- B. IDOT Standard Specification for Road and Bridge Construction, 2015 – Section 205, Embankment. Articles 205.02 to 205.04, 205.06 and 205.07.
- C. IDOT Standard Specification for Road and Bridge Construction, 2015 – Section 208, Trench Backfill. Article 208.02.

## 1.4 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
  - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by an independent geotechnical testing agency, according to ASTM D 1586.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

## 1.5 SUBMITTALS

- A. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

## 1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the using agency or others unless permitted in writing by Construction Manager and then only after arranging to provide temporary utility services according to requirements indicated.
  - 1. Notify Construction Manager not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Construction Manager's written permission.
  - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

## PART 2 PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of [washed] crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

## 2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
- B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
  - 1. Red: Electric.
  - 2. Yellow: Gas, oil, steam, and dangerous materials.
  - 3. Orange: Telephone and other communications.
  - 4. Blue: Water systems.
  - 5. Green: Sewer systems.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 31 10 00 "Site Clearing".
- C. Protect and maintain erosion and sedimentation controls, which are specified in Section 31 10 00 "Site Clearing" during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

### 3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
  - 2. Install a dewatering system, specified in Section 31 23 19 "Dewatering" to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

### 3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

### 3.4 EXCAVATION, GENERAL

- A. Excavation shall conform to Articles 202.02, 202.03 and 202.05 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.
- B. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
  - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
    - a. 24 inches outside of concrete forms other than at footings.
    - b. 12 inches outside of concrete forms at footings.
    - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
    - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    - e. 6 inches beneath bottom of concrete slabs on grade.

### 3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
  - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
  - 1. Clearance: 9 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  - 1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
  - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
  - 3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
  - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

### 3.9 SUBGRADE INSPECTION

- A. Notify Construction Manager when excavations have reached required subgrade.
- B. If Construction Manager determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
  - 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
  - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Construction Manager, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Construction Manager, without additional compensation.



### 3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Construction below finish grade including, where applicable, subdrainage, damproofing, waterproofing, and perimeter insulation.
  - 2. Surveying locations of underground utilities for Record Documents.
  - 3. Testing and inspecting underground utilities.
  - 4. Removing concrete formwork.
  - 5. Removing trash and debris.
  - 6. Removing temporary shoring and bracing, and sheeting.
  - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

### 3.12 UTILITY TRENCH BACKFILL

- A. When utility trenches are in or within 2 feet of pavement, trench backfill will conform to Article 208.02 of the IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.
- C. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- D. Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase.
- E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the utility pipe or conduit.
  - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

- H. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

### 3.13 SOIL FILL / EMBANKMENTS

- A. Preparation shall conform with Article 205.03 of the IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.
- B. Placing shall be in accordance with Article 205.04 of the IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.
- C. Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass and planted areas, use satisfactory soil material.
  - 2. Under walks and pavements, use satisfactory soil material.
  - 3. Under steps and ramps, use engineered fill.

### 3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Compaction shall conform to Article 205.06 of the IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015 unless otherwise specified below.
- B. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- C. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- D. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
  - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.

### 3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.
  - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
  - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
  - 2. Walks: Plus or minus 1 inch.
  - 3. Pavements: Plus or minus 1/2 inch.

### 3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Construction Manager will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

### 3.18 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
  - 1. Scarify or remove and replace soil material to depth as directed by Construction Manager; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.
- D. Protect benchmarks, control points and existing facilities from damage or displacement.
- E. Protect above and below ground utilities which will remain.
- F. Repair damage at own cost.
- G. Protect trees, shrubs, lawns and other features remaining as portion of final landscape.

### 3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal shall conform to Article 202.03 of the IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.

END OF SECTION 312000



## **SECTION 31 23 13 – SUBGRADE PREPARATION**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawing of the Contract, including General and supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - 1. Preparation of the completed earthwork as an unimproved subgrade prior to constructing the pavement structure or appurtenances.
  - 2. Dewatering

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1 Preparation of areas under pavement
  - 2 Preparation of areas turf
- B. Related Sections include the following:
  - 1. Section 01 45 29 “Testing Laboratory Services” for compaction testing of the subgrade.
  - 2. Section 01 57 13 “Temporary Erosion & Sediment Control” for control of storm water runoff.
  - 3. Section 31 10 00 “Site Clearing” for removal of existing materials on site.
  - 4. Section 31 14 12 “Topsoil Excavation and Placement” for the treatment of topsoil.
  - 5. Section 31 20 00 “Earth Moving” for excavation and embankment.
  - 6. Section 32 11 23 “Aggregate Base Courses” for the placement of stone.
  - 7. Section 32 13 14 “Concrete Walks” for the construction of sidewalks.
  - 8. Section 32 16 15 “Cast-In-Place Concrete Curbs” for the construction of curbs.

#### **1.3 REFERENCE STANDARDS**

- A. Conform to IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015, Section 301, Articles 301.02 to 301.04 and 301.08 to 301.10.

## PART 2 PRODUCTS (Not Used)

## PART 3 EXECUTION

### 3.1 EQUIPMENT

- A. In accordance with Article 301.02 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.2 PREPARATION

- A. In accordance with Article 301.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.3 SUBGRADE COMPACTION AND STABILITY

- A. In accordance with Article 301.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.4 AGGREGATE BASE COURSE

- A. The subgrade shall be compacted by rolling with a steel wheel or pneumatic-tired roller. The rolling shall extend at least 12 inches beyond the edge of the base course.

### 3.5 CURBS AND SIDEWALK

- A. In accordance with Article 301.08 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.6 DRAINAGE

- A. In accordance with Article 301.09 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: The Construction Manager will employ a qualified geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

- C. Testing agency will test densities according to Article 301.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015. Tests will be performed at the following locations and frequencies:
  - 1. Paved Areas: At least 1 test for every 2000 sq ft. or less of paved area but in no case fewer than 3 tests.
- D. When the testing agency reports that subgrades, have not achieved the required density and stability have not been attained, the Construction Manager will make a determination as to whether additional drying and recompaction will be needed or whether the ground and soil conditions warrant more extensive treatments. Soft and unstable material that will not compact when rolled or tamped, shall be removed and disposed of according to Article 202.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015, and replaced with materials specified above.
- E. Subgrade replacement:
  - 1. The Construction Manager shall observe the subgrade performance under haul trucks and construction equipment. Areas which exhibit significant surface deflections and the development of rutting shall be identified.
  - 2. The Testing Agency shall test those areas exhibiting surface deflections and rutting with the Dynamic Cone Penetrometer (DCP) to determine the thickness and extents of subgrade treatment.

### 3.8 MAINTENANCE

- A. In accordance with Article 301.10 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.9 PROTECTION

- A. Protect benchmarks, control points and existing facilities form damage or displacement.
- B. Protect above and below ground utilities which will remain.
- C. Repair damage at own cost.
- D. Protect trees, shrubs, lawns and other features remaining as portion of final landscape.

END OF SECTION 312313





## **SECTION 32 11 23 – AGGREGATE BASE COURSE**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings of the Contract, including General and supplementary Conditions and Division 01 Specifications, apply to this Section.
  - 1. Furnishing and placing granular material as a base course on a prepared subgrade for pavements either asphalt or concrete.

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1 Aggregate Bases Courses Under Paved Surfaces
- B. Related Sections include the following:
  - 1. Section 01 45 29 “Testing Laboratory Services” for testing of aggregate materials.
  - 2. Section 01 57 13 “Temporary Erosion and Sediment Control” for the control of storm water runoff from the site.
  - 3. Section 31 10 00 “Site Clearing” for the removal of existing materials on site.
  - 4. Section 31 23 13 “Subgrade Preparation” For the preparation of the subgrade prior to placing aggregates and paving.
  - 5. Section 31 20 00 “Earth Moving” for exaction and embankment.
  - 6. Section 32 13 13 “Concrete Paving” for the preparation of base materials for concrete pavements.
  - 7. Section 32 13 14 “Concrete Walks’ for the preparation of base materials for sidewalks.
  - 8. Section 32 16 15 “Cast-In-Place Concrete Curbs” for the preparation of base materials for curbs.

#### **1.3 REFERENCE STANDARDS**

- A. IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015, Section 351, Articles 351.02 to 351.06 and 351.09 to 351.10.

#### 1.4 SUBMITTALS

- A. Aggregate weight tickets from an IDOT approved source indicating material or aggregate gradation, job designation, purchaser and weight.

#### 1.5 QUALITY ASSURANCE

- A. All aggregate shall be from an IDOT approved source.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Granular Material
  - 1. In accordance with Article 351.02 of the IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
  - 2. Aggregate Base Course, Type B shall be used.
  - 3. Gradation of Aggregate Base Course shall be CA-6.

### PART 3 EXECUTION

#### 3.1 EQUIPMENT

- A. In accordance with Article 351.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

#### 3.2 SUBGRADE PREPARATION

- A. In accordance with Article 351.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

#### 3.3 PLACING AND COMPACTING OF GRANULAR MATERIAL

- A. In accordance with Article 351.05 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
- B. Granular material shall be placed a minimum of 18 inches outside of the proposed pavements.

#### 3.4 TOLERANCE IN THICKNESS

- A. In accordance with Article 351.06 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.5 SHAPING, TRIMMING, AND FINISHING OF AGGREGATE BASE COURSE

- A. In accordance with Article 351.09 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.6 MAINTAINING

- A. In accordance with Article 351.10 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

END OF SECTION 321123



## **SECTION 32 12 16 – ASPHALT PAVING**

### **PART 1 GENERAL**

#### **1.01 WORK INCLUDES**

- A. General Trades Contractor to provide:
  - 1. Furnish, place and compact hot mix asphalt (MHA) binder and surface course on a prepared base according to the details and as shown on the drawings.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 45 29 "Testing Laboratory Services" for testing of asphalt surfaces.
- B. Section 02 41 00 "Demolition" for demolition of existing asphalt pavements.
- C. Section 31 10 00 "Site Clearing" for the removal of existing materials on site.
- D. Section 31 20 00 "Earth Moving" for excavating, backfilling, site grading, and for site utilities.
- E. Section 31 23 13 "Subgrade Preparation" for preparation of subgrade prior to placing asphalt.
- F. Section 32 11 23 "Aggregate Base Courses" for placement of aggregate base before paving.

#### **1.03 REFERENCE STANDARDS**

- A. IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015, Section 406, Articles 406.2, 406.3, 406.5, 406.6, 406.7, 406.8 & 406.12.

#### **1.04 SUBMITTALS**

- A. Bill(s) of Lading for Bituminous Material (Prime Coat)
- B. Hot Mix Asphalt weight tickets from an IDOT approved plant indicating material job designation, purchaser and weight.
- C. Daily Plant Reports
- D. IDOT approved mix designs for each required mixture.
- E. Results of Density Testing.

#### **1.05 QUALITY ASSURANCE**

- A. All Hot Mix Asphalt used on this project shall be produced at an IDOT approved plant.

### **PART 2 PRODUCTS**

## 2.01 MATERIALS

- A. In accordance with Article 406.02 of the IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015.

## PART 3 EXECUTION

### 3.01 EQUIPMENT

- A. In accordance with Article 406.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015.

### 3.02 PREPARATION OF BASE

- A. In accordance with Article 406.05 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015.
- B. Prime coat shall be applied to aggregate bases at a uniform rate of 0.40 gal/sq yd prior to placing Hot Mix Asphalt.
- C. A tack coat shall be applied on top of the binder course prior to placement of the surface course at a uniform rate of 0.08 gal/sq yd.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances and surroundings. Remove spillages and clean affected surfaces.

### 3.03 PLACING

- A. In accordance with Article 406.06 (b) through (g) of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015.

### 3.04 COMPACTION

- A. In accordance with Article 406.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015 except as follows:
  - 1. An intermediate roller will not be required.

### 3.05 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Binder Course: Plus or minus ¼ inch.
  - 2. Surface Course: Plus 1/8 inch, no minus.

- B. Pavement Surface Smoothness: Compact each course to produce a surface smooth-

ness within the following tolerances determined by using a 10-foot straight edge (to be supplied by the contractor) transversely or longitudinally to paved areas:

1. Binder Course: ¼ inch.
2. Surface Course: Plus 3/16 inch, no minus.

### 3.06 FIELD QUALITY CONTROL

- A. Correct asphalt paving work which does not conform to the specified requirements, including density, tolerances and finishes. Correct deficient asphalt pavement as directed by the Construction Manager.
- B. Hot Mix Asphalt testing service: The Construction Manager will employ an approved independent testing laboratory to perform quality assurance tests.
- C. In-Place Density: The Contractor, in the presence of the testing agency will take samples of uncompacted paving mixture and compacted pavement in accordance with IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015.
- D. Tolerances In Thickness: Cores 2 in. in diameter shall be taken from the pavement by the Contractor, at locations selected by the Construction Manager. The Exact location for each core will be selected at random. Core locations will be specified prior to beginning the coring operations.

The Contractor and the Construction Manager shall witness the coring operations, as well as the measuring and recording of the cores. Core measurements will be determined immediately upon removal from the core bit and prior to moving to the next core location. Upon concurrence of the length, the core samples shall be disposed of according to Article 202.03.

Upon completion of coring, all core holes shall be filled with a rapid hardening mortar or concrete. Only enough water to permit placement and consolidation by rodding shall be used, and the material shall be struck-off flush with the adjacent pavement.

- E. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- F. Remove and replace or install additional HMA where test results or measurements indicate it does not comply with specified requirements.

### 3.07 BUTT JOINTS

- A. In accordance with Article 406.08 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015.

### 3.08 PROTECTION OF PAVEMENT

- A. In accordance with Article 406.12 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015.

### 3.09 DISPOSAL

- A. Remove excavated and excess asphalt materials from Project site and legally dispose of them in the EPA-approved landfill.
  - 1. Do not allow materials to accumulate on-site.

END OF SECTION 321216



## **SECTION 32 13 13 – CONCRETE PAVING**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings of the Contract, including General and supplementary Conditions and Division 01 Specifications, apply to this Section.
  - 1. All pavements composed of Portland cement concrete with or without reinforcement, constructed on a prepared subgrade, or subbase with or without forms, according to the details at the locations shown on the plans.

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1 Sidewalks
  - 2 Thickened Edge Sidewalks
  - 3 Utility Pads
  - 4 Drives
- B. Related Sections include the following:
  - 1. Section 01 45 29 "Testing Laboratory Services" for concrete testing.
  - 2. Section 03 30 00 "Cast-in-Place Concrete" for general building applications of concrete.
  - 3. Section 31 23 13 "Subgrade Preparation" for preparation before placing concrete.
  - 4. Section 31 20 00 "Earth Moving" for grading before placing concrete.
  - 5. Section 32 11 23 "Aggregate Base Course" for placing stone prior to concrete paving.

#### **1.3 REFERENCE STANDARDS**

- A. IDOT Standard Specifications for Road and Bridge Construction, 2015 – Section 420, Articles 420.02 to 420.07, 420.09, 420.11 to 420.13 and 420.18.

#### **1.4 SUBMITTALS**

- A. Delivery tickets from an IDOT approved plant indicating material, job designation, purchaser and weight.
- B. IDOT approved mix designs for each required mixture.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. In accordance with Article 420.02 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

## PART 3 EQUIPMENT

- 3.1 In accordance with Article 420.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

## PART 4 EXECUTION

### 4.1 SUBGRADE PREPARATION

- A. In accordance with Article 420.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 4.2 JOINTS

- A. In accordance with Article 420.05 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 4.3 FORMS

- A. In accordance with Article 420.06 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015 except as follows:
  - 1. Slipforming will not be allowed.

### 4.4 PLACING

- A. In accordance with Article 420.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
- B. Notify Construction Manager at least 24 hours prior to scheduled placement of all concrete.
- C. Prior to placement, the Construction Manager will review all lines, grades, elevations, formwork, reinforcement and accessories.

### 4.5 FINISHING

- A. In accordance with Article 420.09 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

#### 4.6 REMOVING FORMS

- A. In accordance with Article 420.11 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

#### 4.7 SEALING JOINTS

- A. In accordance with Article 420.12 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.

#### 4.8 OPENING TO TRAFFIC

- A. In accordance with Article 420.13 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.

#### 4.9 PROTECTIVE COAT

- A. In accordance with Article 420.18 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.

#### 4.10 FIELD QUALITY CONTROL

- A. Correct concrete work which does not conform to the specified requirements, including strength, tolerances and finishes. Correct deficient concrete as directed by the Construction Manager.
- B. Concrete mix proportions may be determined by laboratory tests or by field test methods, complying with ACI 211.1-8.1. Submit written reports to the Construction Manager of each concrete mix. Information submitted to the Construction Manager shall be current.
- C. Concrete testing service: The Construction Manager will employ an approved independent testing laboratory to perform concrete quality evaluation tests.
- D. Quality Control Testing During Construction: Concrete shall be sampled and tested for quality control during the placement of concrete, as follows:
  - 1. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements.
    - a. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. Yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.
      - (1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
      - (2) Slump shall be determined according to Article 1020.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.

- (3) Air content shall be determined according to Article 1020.08 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
  - (4) Compression strength tests shall be performed according to Article 1020.09 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015. Take one set of test samples on each day that concrete is placed for the walks.
  - (5) Compression Test Specimens: ASTM C 31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
- E. Testing laboratory will report test results in writing to the Construction Manager and the General Trades Contractor within 48 hours of testing. Reports of compressive strength tests will contain the project identification name and number, date of concrete placement, name of Contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix identification number, compressive breaking strength and type of break for both 7 day tests and 28 day tests.
- F. Pavement Tolerances shall comply with tolerances of ACI 117 and as follows:
1. Elevation: 1/4 inch (6 mm).
  2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
  3. Surface: Gap below 10-foot- (3-m-) long, unlevelled straightedge not to exceed 1/4 inch (6 mm).
  4. Joint Spacing: 3 inches (75 mm).
  5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
  6. Joint Width: Plus 1/8 inch (3 mm), no minus.
- G. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Construction Manager but will not be used as sole basis for approval or rejection of concrete.
- H. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Construction Manager.
- I. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.
- J. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

#### 4.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

- B. Drill test cores, where directed by Construction Manager, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313



## **SECTION 32 16 15 – CAST-IN-PLACE CONCRETE CURB**

### **PART 1 GENERAL**

#### **1.01 WORK INCLUDES**

- A. General Trades Contractor to provide:
  - 1. Construction of cast-in-place concrete curb and curb & gutter at locations shown on the drawings.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 01 45 29 “Testing Laboratory Services” for testing of concrete.
- B. Section 31 23 13 “Subgrade Preparation” for the preparation of the subgrade prior to placing concrete curbs.
- C. Section 32 11 23 “Aggregate Base Courses” for the placement and preparation of stone before placing concrete curbs.
- D. Section 32 13 13 “Concrete Paving” for related standards of concrete curb construction.

#### **1.03 REFERENCE STANDARDS**

- A. IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015, Articles 606.02 to 606.08, 606.11, 606.12 and 606.13.
- B. IDOT Highway Standard 606001, Concrete Curb Type B and Combination Concrete Curb and Gutter.

#### **1.04 SUBMITTALS**

- A. Delivery tickets from an IDOT approved plant indicating material, job designation, purchaser and weight.
- B. IDOT approved mix designs for each required mixture.

### **PART 2 PRODUCTS**

#### **2.01 MATERIALS**

- A. Provide all materials in accordance with Article 606.02 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

## PART 3 EQUIPMENT

### 3.01 FORMS

- A. Provide all materials in accordance with Article 606.03 (a) of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

## PART 4 EXECUTION

### 4.01 EXCAVATION

- A. In accordance with Article 606.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 4.02 FORMS

- A. In accordance with Article 606.05 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 4.03 CONCRETE PLACEMENT

- A. In accordance with Article 606.06 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
- B. Notify Construction Manager at least 24 hours prior to scheduled placement of all concrete.
- C. Prior to placement, the Construction Manager will review all lines, grades, elevations, formwork, reinforcement and accessories.

### 4.04 JOINTS

- A. In accordance with Article 606.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 4.05 FINISHING

- A. In accordance with Article 606.11 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 4.06 PROTECTIVE COAT

- A. Protective coat will be required if when the curb is constructed after November 15 and the adjacent pavement will be opened to traffic prior to the following April 15 or when directed by the Construction Manager. When required, protective coat shall be in accordance with Article 606.12 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.



#### 4.07 FIELD QUALITY CONTROL

- A. Correct concrete work which does not conform to the specified requirements, including strength, tolerances and finishes. Correct deficient concrete as directed by the Construction Manager.
- B. Concrete mix proportions may be determined by laboratory tests or by field test methods, complying with ACI 211.1-8.1. Submit written reports to the Construction Manager of each concrete mix. Information submitted to the Construction Manager shall be current.
- C. Concrete testing service: The Construction Manager will employ an approved independent testing laboratory to perform concrete quality evaluation tests.
- D. Quality Control Testing During Construction: Concrete shall be sampled and tested for quality control during the placement of concrete, as follows:
  - 1. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements.
    - a. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. Yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.
      - (1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
      - (2) Slump shall be determined according to Article 1020.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.
      - (3) Air content shall be determined according to Article 1020.08 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
      - (4) Compression strength tests shall be performed according to Article 1020.09 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015. Take one set of test samples on each day that concrete is placed for the walks.
      - (5) Compression Test Specimens: ASTM C 31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
- E. Testing laboratory will report test results in writing to the Construction Manager and the General Trades Contractor within 48 hours of testing. Reports of compressive strength tests will contain the project identification name and number, date of concrete placement, name of Contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix identification number, compressive breaking strength and type of break for both 7 day tests and 28 day tests.

4.08 BACKFILL

- A. In accordance with Article 606.13 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

END OF SECTION 321615

## **SECTION 32 16 23 – CONCRETE WALKS**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings of the Contract, including General and supplementary Conditions and Division 01 Specifications, apply to this Section.
  - 1. Construction of Portland cement concrete sidewalks and sidewalk accessibility ramps on a prepared subgrade according to details at locations shown on plans.

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1 Sidewalks
  - 2 Thickened Edge Sidewalks
- B. Related Sections include the following:
  - 1. Section 01 45 29 “Testing Laboratory Services” for testing of concrete.
  - 2. Section 31 23 13 “Subgrade Preparation” for the preparation of the subgrade prior to placing concrete walks.
  - 3. Section 32 11 23 “Aggregate Base Courses” for the placement and preparation of stone before placing concrete walks.
  - 4. Section 32 13 13 “Concrete Paving” for related standards of concrete walk construction.

#### **1.3 REFERENCE STANDARDS**

- A. Conform to IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015, Section 424, Articles 424.02 to 424.11.
- B. IDOT Highway Standard 424001, Curb Ramps for Sidewalks.

#### **1.4 SUBMITTALS**

- A. Delivery tickets from an IDOT approved plant indicating material, job designation, purchaser and weight.
- B. IDOT approved mix designs for each required mixture.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. In accordance with Article 424.02 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

## PART 3 EQUIPMENT

- 3.1 In accordance with Article 424.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

## PART 4 EXECUTION

### 4.1 SUBGRADE PREPARATION

- A. In accordance with Article 424.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 4.2 FORMS

- A. In accordance with Article 424.05 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015 except as follows:
  - 1. Slipforming will not be allowed.

### 4.3 PLACING AND FINISHING

- A. In accordance with Article 424.06 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
- B. Notify Construction Manager at least 24 hours prior to scheduled placement of all concrete.
- C. Prior to placement, the Construction Manager will review all lines, grades, elevations, formwork, reinforcement and accessories.

### 4.4 JOINTS

- A. In accordance with Article 424.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015 and as shown on the drawings.

### 4.5 CURB RAMPS

- A. In accordance with Article 424.08 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

#### 4.6 DETECTABLE WARNINGS

- A. In accordance with Article 424.09 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.

#### 4.7 FIELD QUALITY CONTROL

- A. Correct concrete work which does not conform to the specified requirements, including strength, tolerances and finishes. Correct deficient concrete as directed by the Construction Manager.
- B. Concrete mix proportions may be determined by laboratory tests or by field test methods, complying with ACI 211.1-8.1. Submit written reports to the Construction Manager of each concrete mix. Information submitted to the Construction Manager shall be current.
- C. Concrete testing service: The Construction Manager will employ an approved independent testing laboratory to perform concrete quality evaluation tests.
- D. Quality Control Testing During Construction: Concrete shall be sampled and tested for quality control during the placement of concrete, as follows:
  - 1. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements.
    - a. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. Yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.
      - (1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
      - (2) Slump shall be determined according to Article 1020.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, January 1, 2015.
      - (3) Air content shall be determined according to Article 1020.08 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
      - (4) Compression strength tests shall be performed according to Article 1020.09 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015. Take one set of test samples on each day that concrete is placed for the walks.
      - (5) Compression Test Specimens: ASTM C 31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

- E. Testing laboratory will report test results in writing to the Construction Manager and the General Trades Contractor within 48 hours of testing. Reports of compressive strength tests will contain the project identification name and number, date of concrete placement, name of Contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix identification number, compressive breaking strength and type of break for both 7 day tests and 28 day tests.

#### 4.8 BACKFILL

- A. In accordance with Article 424.10 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

#### 4.9 DISPOSAL OF SURPLUS MATERIAL

- A. In accordance with Article 424.11 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

END OF SECTION 321314

## **SECTION 32 31 13 – CHAIN LINK FENCES AND GATES**

### **PART 1 GENERAL**

#### **1.01 WORK INCLUDES**

- A. General Trades Contractor to provide:
  - 1. All work related to installing temporary, 6 foot high, chain link fence, and swing gates for construction security purposes (phase 1 & 2).
  - 2. Removal of a portion of construction fence for phase 2 construction fencing.
  - 3. Removal of entire fence at the completion of the project.

#### **1.02 REFERENCE STANDARDS**

- A. Conform to IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan. 1, 2015, Section 664, Articles 664.02 to 664.09 and 664.11.
- B. IDOT Highway Standard 664001, Chain Link Fence.

#### **1.03 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, and finishes of components. Include plans, gate elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.

#### **1.04 QUALITY ASSURANCE**

- A. Use adequate members of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.

### **PART 2 PRODUCTS**

#### **2.01 MATERIALS**

- A. Chain link fence shall be 6 feet in height.
- B. In accordance with Article 664.02 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015

### **PART 3 EXECUTION**

### 3.01 PREPARATION

- A. In accordance with Article 664.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015

### 3.02 INSTALLING POSTS

- A. In accordance with Article 664.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.03 POST TOPS

- A. In accordance with Article 664.05 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.04 TENSION WIRE

- A. In accordance with Article 664.06 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.05 BRACES

- A. In accordance with Article 664.06 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.06 FABRIC

- A. In accordance with Article 664.08 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.07 GATES

- A. In accordance with Article 664.09 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.08 PROTECTIVE ELECTRICAL GROUND

- A. In accordance with Article 664.11 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.09 FIELD QUALITY CONTROL



- A. Grounding-Resistance Testing: Construction Manager will engage a qualified independent testing agency to perform field quality-control testing.

### 3.10 PHASING, REMOVAL & CLEAN UP

- A. Remove portion of phase 1 fencing and install additional fencing according to the plans when directed to do so by the Construction Manager.
- B. Remove all construction fencing at project completion, backfill post holes with topsoil in grass areas and fill with mortar in pavement areas.
- C. All fencing and related items shall be removed from the site and properly disposed of by the General Trades Contractor at the completion of the project.
- D. Areas of fencing shall be restored to original condition and free of all fencing items and debris at the completion of the project.

END OF SECTION 323113



## **SECTION 33 05 13 – MANHOLE AND STRUCTURES**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings of the Contract, including General and supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - 1. Shown on the drawings.

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1. Manholes
  - 2. Inlets
  - 3. Catch Basins
- B. Related Sections include the following:
  - 1. Section 01 74 13 – “Construction Cleaning” for measured to keep the construction site clear of dirt and debris during construction.
  - 2. Section 01 74 23 – “Final Cleaning” for cleaning the job site after construction.
  - 3. Section 33 49 13 – “Storm Drainage Inlets and Manholes, Frames and Covers” for related storm sewer appurtenances.

#### **1.3 REFERENCE STANDARDS**

- A. Conform to IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015, Section 602, Articles 602.02 to 603.15.

#### **1.4 SUBMITTALS**

- A. Manufacturer's written certification indicating compliance with applicable codes and specifications. Data shall indicate joint materials for joining of precast sections. Submit data on: adjusting rings and other associated structures.

### **PART 2 PRODUCTS**

#### **2.1 MATERIALS**

- A. In accordance with Article 602.02 IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

## PART 3 EXECUTION

### 3.1 ADJUSTMENT

- A. In accordance with Article 602.03(a) of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
- B. Method of adjustment shall be accordance with applicable portions of Section 602 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.2 EXCAVATION AND BACKFILLING

- A. In accordance with Article 602.12 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.3 CLEANING

- A. In accordance with Article 602.15 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

END OF SECTION 330513

## **SECTION 33 11 00 – WATER UTILITY DISTRIBUTION PIPING**

### **PART 1 GENERAL**

#### **1.01 WORK INCLUDES**

- A. Plumbing Contractor to provide:
  - 1. The disconnection of the existing water service to the building to be demolished including:
    - a. Necessary fittings and appurtenances.
    - b. Disconnection per City of Joliet code.
    - c. Surface repairs to street, parking lot, sidewalk, etc.

#### **1.02 RELATED WORK:**

- A. Section 01 45 29 "Testing Laboratory Services" for testing of the water mains.
- B. Section 01 33 23 "Shop Drawings, Product Data, & Samples" for submittal requirements of materials to be used.
- C. Section 33 31 00 "Sanitary Utility Sewerage Piping" for related utility piping and requirements.
- D. Section 33 41 00 "Storm Utility Drainage Piping" for related utility piping and requirements.

#### **1.03 REFERENCE STANDARDS**

- A. Standard Specifications for Water and Sewer Main Construction in Illinois, Seventh Edition, July, 2014.

#### **1.04 SUBMITTALS**

- A. Product data: Within thirty (30) calendar days after the Contractor has received the NOTICE TO PROCEED, submit:
  - 1. Materials list of items proposed to be provided under this section
  - 2. Manufacturers' specifications, catalog cuts, and other data needed to prove compliance with the specified requirements
  - 3. Shop drawings and other data, as required, to indicate method of installing and attaching equipment, except where such details are fully shown on the drawings
- B. Disinfection certificate:
  - 1. Upon completion of water line disinfection in accordance with Article 41-2.15 A through I of the "Standard Specifications for Sewer and Water Main Construction," deliver to the Engineer two (2) copies of an acceptance "Certificate of Performance" for that activity.

## 1.05 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

## PART 2 PRODUCTS

### 2.01 PIPE AND FITTINGS

- A. Watermain pipe shall be slip-joint, PVC pressure pipe meeting the requirements of AWWA C-900, SDR-18. Ductile iron pipe shall be cement lined, mechanical joint, Class 52 meeting the requirements of ANSI/AWWA A21.51/C-151. Fittings shall be cement-lined, slip or mechanical joint, ductile iron, pressure rated for 250 PSI and meeting the requirements of ANSI/AWWA A21.10/C-110 and ANSI/AWWA A21.11/C-111.
- B. Water service shall conform to Article 40-2.06A "Copper Service Pipe" of the Standard Specifications for water and sewer construction in Illinois, Seventh Edition, July 2014.

### 2.02 VALVES & ACCESSORIES

- A. Curb Stop and Box:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amcast Industrial Corporation; Lee Brass Co.
    - b. Ford Meter Box Company, Inc. (The); Pipe Products Div.
    - c. Jones, James Company.
    - d. Master Meter, Inc.
    - e. McDonald, A. Y. Mfg. Co.
    - f. Mueller Co.; Water Products Div.
    - g. Red Hed Manufacturing & Supply.
  - 2. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.
    - a. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.
- B. Water Service:
  - 1. Water service lines shall be copper, Type "K", conforming to ASTM B88 and B251.
- C. Tracer Wire:
  - 1. Wire shall be 8 gauge bare copper wire.
- D. Warning/Locator Tape:
  - 1. Tape shall be metal or foil marked "WATER MAIN BELOW" or equivalent.

## 2.03 PRODUCT HANDLING

- A. Piping and fittings shall be stored according to manufacturer's limitations of stacking and exposure to sunlight and weather.
- B. Stacked piping shall be covered with a heavy black vinyl tarp, firmly tied into place. Piping shall be fully supported off the ground.
- C. Do not stack other materials on top of stored piping and conduit.
- D. The ends of carrier piping and conduit shall be securely covered, such that moisture, dirt, animals and vermin cannot gain entrance.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install all pipe, fittings, valves and other related items as shown on the plans or mentioned in these specifications in strict accordance with manufacturer's specifications.
- B. Installation of services shall be in strict accordance with the Standard Specifications for Water & Sewer Main Construction in Illinois, Seventh Edition, July 2014.
- C. No water main service tap will be allowed within eighteen inches (18") of an existing service tap or water main fitting.
- D. Tracer wire shall be attached to the top of the water main and all metal castings on valve boxes or vaults.
- E. Warning/locator tape shall be laid in trench between 24 and 30 inches below final grade.

### 3.02 DISPOSAL OF EXISTING MATERIALS

- A. In accordance with Article 202.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.03 INTERRUPTIONS TO UTILITIES

- A. In addition to the requirements of the "Water and Sewer Main Specifications", any unmarked water services or mains damaged by the Contractor shall be repaired by the Contractor in a timely manner. The cost of the repair shall be the responsibility of whoever caused the damage.

### 3.04 DISINFECTION OF WATERMAINS

- A. The mains shall be flushed prior to disinfection and disinfected in accordance with Section 41-2.15 A through I of the "Water and Sewer Main Specifications". The Contractor shall arrange for and pay the costs of the tests.

- B. All water mains shall be satisfactorily disinfected prior to use, in accordance with the requirements of AWWA C651-99, at least one set of samples shall be collected from every 1,200 feet of new water main, plus one set from the end of the line and at least one set from each branch. Satisfactory disinfection shall be demonstrated in accordance with the requirements of 35 Ill. Adm. Code 65.203.

### 3.05 TESTING

- A. The watermain shall be pressure tested in accordance with Section 41-2.14 (A through C) of the "Water and Sewer Main Specifications" and the following modifications. If the joints and service connections are not visible, the duration of the pressure test shall be twenty-four (24) hours.
- B. The Contractor shall take care to ensure that all air has been expelled from the pipe prior to applying the specified test pressure.
- C. Provide personnel and equipment; and arrange for and pay the costs of all required tests and inspections.
- D. Where tests show materials or workmanship to be deficient, replace or repair, as necessary, and repeat the tests until the specified standards are achieved.
- E. After disinfection and testing, the gate valves on all dead end mains, that will be extended in the future, shall be closed.

### 3.06 HORIZONTAL & VERTICAL SEPARATION

- A. Horizontal and vertical separation must be maintained in accordance with Section 41-2.01(A and B) of the "Standard Specifications for Water & Sewer Main Construction in Illinois" dated July 2014, 7<sup>th</sup> Edition.
- B. Follow the related provisions of Section 41-2.01(A and B) of the "Standard Specifications for Water & Sewer Main Construction in Illinois" dated July 2014, 7<sup>th</sup> Edition when horizontal and vertical separation is impossible to achieve.

END OF SECTION 331100



## **SECTION 33 31 00 – SANITARY UTILITY SEWERAGE PIPING**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings of the Contract, including General and supplementary Conditions and Division 01 Specifications, apply to this Section.
  - 1. Disconnection of sanitary sewerage service as shown on the drawings, specified herein, and needed for a complete and proper disconnection, including but not necessarily limited to:
    - (1) Necessary fittings and appurtenances.
    - (2) Necessary protection for water main that does not meet the standard horizontal and vertical separation requirements.

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1. Sanitary Sewer pipe
  - 2. Sanitary Service pipe
- B. Related Sections include the following:
  - 1. Section 01 45 29 – “Testing Laboratory Services” for testing.
  - 2. Section 01 33 23 – “Shop Drawings, Product Data, & Samples” for submittal requirements of material to be used.

#### **1.3 REGULATORY REQUIREMENTS**

- A. Local Building Code
- B. Illinois Department of Public Health Plumbing Code
- C. Standard Specifications for Water and Sewer Main Construction in Illinois, Seventh Edition, July 2014, Section 33.

#### **1.4 SUBMITTALS**

- A. Product data: Within thirty (30) calendar days after the Contractor has received the NOTICE TO PROCEED, submit:
  - 1. Materials list of items proposed to be provided under this section.
  - 2. Manufacturers' specifications, catalog cuts, and other data needed to prove compliance with the specified requirements.

3. Shop drawings and other data, as required, to indicate method of installing and attaching equipment, except where such details are fully shown on the drawings.
4. Manufacturer's recommended installation procedures which, when approved by the Construction Manager, will become the basis for accepting or rejecting actual installation procedures used on the work.

## 1.5 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

## PART 2 PRODUCTS

### 2.1 SEWER PIPE

- A. Sanitary sewer shall be constructed of slip-on or mechanical joint cast or ductile iron pipe, pre stressed concrete pipe, or PVC pipe equivalent to water main standards of construction, per Section 40-2.01 of the Standard Specifications for Sewer & Watermain Construction of Illinois, Seventh Edition, 2014.

### 2.2 PRODUCT HANDLING

- A. Piping and fittings shall be stored according to manufacturer's limitations of stacking and exposure to sunlight and weather.
- B. Stacked piping shall be covered with a heavy black vinyl tarp, firmly tied into place. Piping shall be fully supported off the ground.
- C. Do not stack other materials on top of stored piping and conduit.
- D. The ends of carrier piping and conduit shall be securely covered, such that moisture, dirt, animals and vermin cannot gain entrance.

## PART 3 EXECUTION

### 3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

### 3.2 INSTALLATION

#### A. Pipe & Fittings

1. Piping shall be installed by the open trench method. Where pipe is to be placed in an area to be filled, the fill shall be complete prior to excavation and installation of

- pipe.
2. Trenches shall be kept free of water until bedding, laying, and backfilling operations are completed.
  3. Surplus excavated material from trenches shall be removed and disposed of as directed by the Construction Manager.
  4. Connection will be made to the existing 4" pipe stub provided at the existing building and at the location shown on the plans.
  5. Temporary blocking of bricks, timbers, or other objects used when laying pipe shall be removed and the voids filled with compacted bedding material prior to backfilling.
  6. For sewers with less than 3.5' of cover, 6 inches of foam type insulation shall be added over the bedded pipe before final backfilling.

### 3.3 SERVICE SEWERS

- A. Service sewers shall terminate at five (5') from the new building line with a bell end. A watertight plug shall be inserted in the bell end. The plug will be considered incidental to the construction of the service sewers.
- B. The depth of the service sewer at the new building shall be as noted on the plans.

### 3.4 SEWER INSPECTION AND TESTS

- A. Inspections and tests will be carried out under the direction of the Construction Manager as work progresses in order to assure that the quality of the workmanship meets the standards of these specifications.
- B. Watertightness Tests:
  1. The sanitary sewer system shall be tested, either as work progresses or after completion of the work, for watertightness by implementation of an exfiltration test, an infiltration test, or an air test in accordance with Section 31-1.12 of the "Water and Sewer Specifications.". Maximum leakage outward or inward shall not exceed 200 gallons per day per inch of diameter per one mile of sewer pipe. The test for watertightness to be utilized shall be determined by the Construction Manager and shall be so stated in writing.

### 3.5 HORIZONTAL & VERTICAL SEPARATION

- A. Horizontal and vertical separation must be maintained in accordance with Section 41-2.01(A and B) of the "Standard Specifications for Water & Sewer Main Construction in Illinois" dated July 2009, 6<sup>th</sup> Edition.
- B. Follow the related provisions of Section 41-2.01(A and B) of the "Standard Specifications for Water & Sewer Main Construction in Illinois" dated July 2009, 6<sup>th</sup> Edition when horizontal and vertical separation is impossible to achieve.

END OF SECTION 333100



## **SECTION 33 41 00 – STORM UTILITY DRAINAGE PIPING**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings of the Contract, including General and supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - 1. General Contractor to perform:
    - a. Furnish and install storm sewer as shown on the drawings.

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1 Concrete Storm Sewer
  - 2 PVC Storm Service Collection Stubs
- B. Related Sections include the following:
  - 1. Section 01 33 23 – “Shop Drawings, Product Data & Samples Schedule” for submittal requirements of materials to be used.
  - 2. Section 31 20 00 – “Earth Moving” for trenching and backfilling requirements.
  - 3. Section 33 49 13 – “Storm Drainage Inlets and Manholes, Frames and Covers” for related appurtenances.

#### **1.3 REFERENCE STANDARDS**

- A. Conform to IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015, Section 550, Articles 550.02 to 550.04 and 550.06 to 550.07.

#### **1.4 SUBMITTALS**

- A. Manufacturer/Supplier’s written certification indicating compliance with Section 1.03.
- B. Trench backfill weight tickets from an approved source indicating material or aggregate gradation, job designation, purchaser and weight.

### **PART 2 PRODUCTS**

#### **2.1 MATERIALS**

- A. Trench Backfill
  - 1. In accordance with Article 208.02 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

- B. Storm Sewer
  - 1. In accordance with Article 550.02 and 550.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
- C. Storm Sewer, Rubber Gasket
  - 1. Precast Reinforced Concrete Pipe of the diameter with rubber gasket joints which conform to ASTM Specification C-361.
  - 2. The joint shall be approved by the Illinois Environmental Protection Agency for storm sewer lines crossing above water mains.

## PART 3 EXECUTION

### 3.1 SEQUENCE

- A. All storm sewers shall be installed prior to the construction of the HMA pavement.

### 3.2 EXCAVATION AND FOUNDATION

- A. In accordance with Article 550.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.3 LAYING OF STORM SEWER PIPE

- A. In accordance with Article 550.06 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
- B. In accordance with IDOT Highway Standard 280001, Temporary Erosion Control Systems.

### 3.4 BACKFILLING

- A. In accordance with Article 550.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
- B. Method 1 backfilling shall be required.
- C. This work also includes the disposal of the surplus excavated material which is replaced by trench backfill. Such disposal shall be made according to Article 202.03 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

END OF SECTION 334100

## **SECTION 33 49 13 – STORM DRAINAGE INLETS & MANHOLES, FRAMES & COVERS**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings of the Contract, including General and supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  - 1. Furnish and install storm drainage structures, frames and covers as shown on the drawings.

#### **1.2 SUMMARY**

- A. This Section includes:
  - 1 Frame and Grates, Lids
  - 2 Grates
- B. Related Sections include the following:
  - 1. Section 01 33 23 – “Shop Drawings, Product Data & Samples” for submittal requirements of materials to be used.
  - 2. Section 31 23 13 – “Subgrade Preparation” for the preparation of soils prior to paving.
  - 3. Section 31 20 00 – “Earth Moving” for excavation and embankment.
  - 4. Section 33 05 13 – “Manhole Grade Adjustment” for the requirements of existing structures.
  - 5. Section 33 41 00 – “Storm Utility Drainage Piping” for construction requirements related to storm sewers.

#### **1.3 REGULATORY REQUIREMENTS**

- A. Conform to IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015, Section 602, Articles 602.02, 602.07, 602.10, 602.11 to 602.13 and 602.15 and Article 604.03.
- B. IDOT Highway Standards:
  - 1. Standard 602601 – Precast Reinforced Concrete Flat Slab Top.

#### **1.4 SUBMITTALS**

- A. Manufacturer's written certification indicating compliance with applicable codes and specifications. Data shall indicate joint materials for joining of precast sections. Submit data on: storm sewer inlets, Precast reinforced concrete flat slab tops, frames, grates, lids and other associated structures.

### **PART 2 PRODUCTS**

## 2.1 MATERIALS

- A. Storm Drainage Inlets and Manholes
  - 1. In accordance with Article 602.02, 604.02 IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.
  - 2. Inlets shall be precast reinforced concrete.
- B. Frames, Grates and Lids
  - 1. In accordance with Article 602.02, 604.03 IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

## PART 3 EXECUTION

### 3.1 PRECAST REINFORCED CONCRETE SECTIONS

- A. In accordance with Article 602.07 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.2 FURNISHING AND PLACING CASTINGS

- A. In accordance with Article 602.121 and 604.04 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.3 EXCAVATION AND BACKFILLING

- A. In accordance with Article 602.12 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.4 INLET AND OUTLET PIPES

- A. In accordance with Article 602.13 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

### 3.5 CLEANING

- A. In accordance with Article 602.15 of IDOT Standard Specifications for Road and Bridge Construction, including all supplements, Jan 1, 2015.

END OF SECTION 334913