PROJECT MANUAL - VOLUME 3
Div 21 – Div 28

Issued for Bidding: July 17, 2015
Project No.: 14-004

MULTI-PURPOSE FACILITY
Bid Package 2

for

Joliet Junior College
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Joliet, Illinois 60431

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DIVISION 1 - GENERAL REQUIREMENTS

DIVISION 3 - CONCRETE

DIVISION 4 - MASONRY

DIVISION 5 - METALS

DIVISION 6 - WOOD, PLASTICS, AND COMPOSITES

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

DIVISION 8 - DOORS AND WINDOWS

DIVISION 22 - PLUMBING

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

DIVISION 26 - ELECTRICAL

SECTION 21 05 00 - BASIC FIRE SUPPRESSION REQUIREMENTS

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 ALTERNATES

A. Alternate #1: Add Storage 1015 to fire protection zone 1. Refer to 1/FP2.00 for more information.

B. Alternate #2: Add Storage 1015 to fire protection zone 1. Refer to 2/FP2.00 for more information.

C. Alternate #3: Add Storage 1015 and Storage 1016 to fire protection zone 1. Refer to 3/FP2.00 for more information.

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, hydronic 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, IL 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:

Referenced Specification Section	**Submittal Item**
21 13 00	Sprinkler Systems
21 13 00	Fire Protection Equipment
Refer to Drawings	Fire Protection 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., fire protection, 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., fire protection, 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, 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., backflow preventer, etc.) using the project nomenclature (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 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. Fire Seal Systems

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.

1.13 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.

1.14 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 21 08 00, and provide all services necessary for compliance with LEED Prerequisite EAp1 and Fundamental Commissioning.

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.

3.3 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.

3.4 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 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. Start-up reports on all equipment requiring a factory installation inspection or start-up.

6. 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.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.

3.6 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.

C. Before completion of the project, a set of reproducible fire protection 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.

3.8 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. 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 per the Architect.

G. In accordance with LEED EQc4.2: Low-Emitting Materials - Paints and Coatings, all paints and coatings used on the interior of the building must comply with the following criteria:

1. Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.

2. Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L (2 lb./gal) established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

3. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

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.

D. 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 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

a. Minimizing the amount of dust generated.
b. Reducing solvent fumes and VOC emissions.
c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.

2. Request that the Owner designate an IAQ representative.

3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.

4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.

5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.

6. Request copies of and follow all of the Owner's IAQ and infection control policies.

7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.

8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.

9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

3.12 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, 75% of the construction and demolition debris for this project must be recycled or salvaged.

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.

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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. The Building Officials and Code Administrators National Building Code
H. Wisconsin Administrative Code
I. 2003 International Building Code.
J. 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, all Contractors 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

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

Penetrating Item	UL System No.
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

Penetrating Item	UL System No.
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

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

Penetrating Item	UL System No.
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 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.

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
2" and smaller	3/8"
2-1/2" through 3-1/2"	1/2"
4" and 5"	5/8"
6"	3/4"

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.

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 318-02. 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 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install 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.

2. All steel supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.

C. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.

2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.

3. Grout around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Coordinate all openings with other Contractors.

B. 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.

C. 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.

D. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.5 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 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. 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 duct and 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 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. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.

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, 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. 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.

F. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

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

	Pipe Material	Maximum Spacing
1.	Steel (Std. Weight or Heavier – Liquid Service):	
	1-1/4" & under	7'-0"
	1-1/2"	9'-0"

Pipe Material	Maximum Spacing
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 shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

O.D. of Pipe	Marker Length	Size of Letters
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

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

B. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

C. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

D. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

E. 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 shall have numbered tags.

2. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.

3. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.

4. Number all tags and show the service of the pipe.

5. Provide two sets of laminated 8-1/2" x 11" copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

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. Fasten nameplates or tags with stainless steel self-tapping screws or permanently bonding cement.

3.2 SCHEDULE

A. Pipes to be marked:

Pipe Service	Lettering Color	Background Color
Fire Protection Water	White	Red
Sprinkler Water	White	Red

B. All piping downstream of the fire protection backflow preventer, upstream of sprinkler zone valves, standpipe piping, and combination sprinkler standpipe piping shall be labeled Fire Protection Water. All piping downstream of sprinkler zone valves shall be labeled Sprinkler Water.

END OF SECTION 21 05 53

SECTION 21 08 00 - COMMISSIONING OF FIRE PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning is the process for ensuring that the Fire Protection System is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Fire Protection System from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
   1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
   2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
   3. Verify O&M documentation submitted is complete.
   4. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
   5. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
   6. Furnish labor and material to accomplish fire protection system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

A. Section 01 9113 – General Commissioning Requirements.

B. Section 01 9114 – Functional Testing Requirements

C. Division 21 Sections pertaining to the Fire Protection Systems included in the commissioning program.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing and/or Functional Performance Testing and report from the Provider having jurisdiction is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 9113 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.

B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.

C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.

D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxP.

E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.

F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the Fire Marshal. The CxP may elect to witness the test along with the Fire Marshal or separately.

3.2 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.4 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing
   1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 91 14 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION 21 08 00

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 designed, certified, and shall include the NICET certification block or the Professional Engineer seal of the fire protection designer. Fire protection designer shall be NICET Level III or Level IV certified or be a licensed Professional Engineer.

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/ASME B16.25 - Butt-Welding Ends.

H. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

I. ANSI/ASME Section 9 - Welding and Brazing Qualifications.

J. ANSI/ASTM A47 - Malleable Iron Castings.

K. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.

L. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.

M. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.

N. ASME - Boiler and Pressure Vessel Code - Section IX, Welding and Brazing Requirements.

O. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.

P. AWS A5.8 - Brazing Filler Metal.

Q. AWS B2.2 - Standard for Brazing Procedure and Performance Qualification.

R. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

S. IBC - International Building Code.

T. MSS SP-73 - Brazing Joints for Wrought and Cast Copper Alloy Solder Joint and Pressure Fittings.

U. NFPA 101 - Life Safety Code,

V. NFPA 13 - Installation of Sprinkler Systems.

W. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

X. UL - Underwriter's Laboratory Fire Protection Equipment Directory.

1.4 EXTRA STOCK

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

1.5 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.

1.6 SYSTEM DESCRIPTION

A. System shall cover building areas noted.

B. System shall interface with building fire alarm system. Provide all required wiring.

C. Provide wet pipe sprinkler system(s) to NFPA 13 and building code requirements as required by Owner's insurance company and as shown on the drawings.

D. Provide a Fire Department connection.

1.7 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.

1.8 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.

1.9 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.

1.10 OPERATION AND MAINTENANCE DATA

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

1.11 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 FLEXIBLE SPRINKLER HOSE WITH THREADED END FITTINGS

A. UL listed per UL 2443.

B. Construction:

1. Hose:

a. Type 304 stainless steel.
b. Straight or elbow hose - maximum six (6)-foot hose length.
c. 1/2" or 3/4" outlet.
d. 175 psi rated pressure.
e. Leak-tested minimum 7/8".
f. Minimum 7/8" hose.
g. O-ring sealed joints are not acceptable.

2. Ceiling Bracket:

a. Zinc plated or galvanized steel – 24" and 48" sizes.
b. Flexible hose attachment: Open hub or set screw.

3. Unit may be prepackaged with sprinkler head.

C. Acceptable Manufacturers: FlexHead Industries, Victaulic Aquaflex.

2.3 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.

2.4 VALVE OPERATORS

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

2.5 VALVE CONNECTIONS

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

2.6 BACKFLOW PREVENTERS

A. Provide backflow preventers as required by code and as specified on the drawings.

2.7 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 - VALVES

A. Install gate valves with stems upright or horizontal, not inverted.

B. Backflow Preventer:

1. Units shall be field tested and tagged in accordance with manufacturer's instructions by a certified tester before initial operation.

2. Install unit between 12" and 60" above finish floor.

C. Shutoff Valve:

1. Provide drain valves at main shutoff valves, low points of piping and apparatus.

3.3 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. Fire Department Connection:

1. Locate fire department connection in an accessible location as approved by the local fire department with sufficient clearance from walls, obstructions, and adjacent Siamese connectors to allow full swing of fire department wrench handle.

C. Alarm Bell:

1. Locate outside alarm bell on building wall as shown on drawings.

2. Wire all bells, flow switches and supervisory switches to fire alarm system. All wiring shall be in conduit and meet the requirements of the electrical specifications.

D. 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.

E. 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 in areas with 2'x4' ceiling tiles, centering using a 2'x2' ceiling pattern is acceptable.

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.

3.4 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. Underground Piping:

1. Flush all underground piping with minimum flow equal to the system design flow but not less than the following:

a. 390 gpm for 4" pipes.
b. 880 gpm for 6" pipes.
c. 1560 gpm for 8" pipes.

2. Branches from new underground mains to sprinkler risers shall be flushed out through two 2-1/2" hoses (with flow through open hose butts) attached to the riser with 4" temporary piping. Flushing through the drain of an alarm check or dry pipe valve is not acceptable.

C. 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.

D. 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 ALTERNATES

A. Alternate #1: Add storm piping to serve Storage 1015. Refer to P1.40 for more information.

B. Alternate #2: Add storm piping to serve Storage 1015. Refer to P1.41 for more information.

C. Alternate #3: Add storm piping to serve Storage 1015 and Storage 1016. Refer to P1.42 for more information.

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, hydronic 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, IL 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:

Referenced Specification Section	**Submittal Item**
22 05 13	Motors
22 14 29	Sump Pumps
Refer to drawings	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, 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, etc.)
   g. Description of item submitted (using project nimenclature) 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. Commissioning
    i. Record drawings
    j. 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. Fire Seal Systems

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.

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.

1.13 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.

1.14 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 22 08 00, and provide all services necessary for compliance with LEED Prerequisite EAp1 and Fundamental Commissioning.

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.

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 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.

3.5 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. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.

3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.

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 - four hours.
2. Water Softener System - four 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. 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. Color of paint shall be per the Architect.

H. In accordance with LEED EQc4.2: Low-Emitting Materials - Paints and Coatings, all paints and coatings used on the interior of the building must comply with the following criteria:

1. Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.

2. Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L (2 lb./gal) established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

3. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

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.

D. 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.

3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the outdoor areas near the building. These measures shall include, but not be limited to:

1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

a. Minimizing the amount of dust generated.
b. Reducing solvent fumes and VOC emissions.
c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
d. Protect stored on-site and installed absorptive materials from moisture damage.

2. Request that the Owner designate an IAQ representative.

3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.

4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.

5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.

6. Request copies of and follow all of the Owner's IAQ and infection control policies.

7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.

8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.

9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

3.13 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, 75% of the construction and demolition debris for this project must be recycled or salvaged.

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. The Building Officials and Code Administrators National Building Code
H. 2003 International Building Code
I. 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, all Contractors 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

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

Penetrating Item	UL System No.
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

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

Penetrating Item	UL System No.
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 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 13 - MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single 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/NEMA MG 1 - Motors and Generators.

E. ANSI/NFPA 70 - National Electrical Code.

F. Energy Independence and Security Act of 2007.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 05 00. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.

B. Submit motor data with equipment when motor is installed by the manufacturer at the factory.

1.4 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.

1.5 OPERATION AND MAINTENANCE DATA

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

1.6 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 40ºC 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.

I. Bearings shall be sealed type for 10 HP and smaller motors.

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

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"
6"	3/4"	5/8"
8" through 12"	7/8"	3/4"

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.

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. Hangers in direct contact with copper pipe shall be coated with plastic with appropriate temperature range. HYDRA-ZORB clamps are permitted for this application for bare pipes within their temperature limits of -65°F to +275°F.

H. 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	Bare Copper Pipe
Anvil	Fig. 260	
Cooper/B-Line	Fig. 3100	Fig. B3100C
Erico	Model 400	
Nibco/Tolco	Fig. 1	Fig. 81PVC

2. Adjustable Swivel Ring Type:
Service: Bare Metal Pipe - 4 inches and Smaller

Acceptable Products:	Bare Steel Pipe	Bare Copper Pipe
Anvil	Fig. 69	
Cooper/B-Line	Fig. B3170NF	Fig. B3170CTC
Erico	Model FCN	102A0 Series
Nibco/Tolco	Fig. 200	Fig. 203

I. 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.

2. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

J. 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. Clamps in direct contact with copper pipe shall be plastic coated.

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

Acceptable Products:	Bare Steel, Plastic or Insulated Pipe	Bare Copper Pipe
Unistrut	Fig. P1100 or P2500	
Cooper/B-Line	Fig. B2000 or B2400	Fig. BVT
Nibco/Tolco	Fig. A-14 or 2STR	

K. 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.

L. 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.

M. 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 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.

2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).

2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a “dirt-trap”.

3. Concrete materials and workmanship required for the Contractor's work shall be provided by him. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6” x 6”, W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.

4. Equipment requiring bases is as follows:

a. Water Heater
b. Water Softener

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.

2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.

2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.

3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Coordinate all openings with other Contractors.

B. 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.

C. 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.

D. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.5 ROOF PENETRATIONS

A. Seal pipes with surface temperature below 150ºF 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 60ºF and 150ºF. Seal outdoor insulation edges watertight.

2.6 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. 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.

J. Wall Seals ("Link-Seals"):

1. Where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.

2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve. If piping carries only fluids below 120ºF, sleeves may be thermoplastic with integral water seal and textured surface.

3. Sleeves shall be at least 2 pipe sizes larger than the pipes.

4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.

5. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40ºF to 250ºF

6. Acceptable Manufacturers: Thunderline Corporation "Link-Seals", O-Z/Gedney Company, Calpico, Inc., Innerlynx, or Metraflex Company (cold service only).

2.7 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.

2.8 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.

2.9 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.

2.10 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. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.

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 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. 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.

F. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

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

	Pipe Material	Maximum Spacing
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.	Steel (Std. Weight or Heavier – Vapor Service):	
	1-1/4" and under	9'-0"
	1-1/2"	12'-0"
	2" & larger	12'-0"

	Pipe Material	Maximum Spacing
3.	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"
	4"	12'-0"
	6"	12'-0"
4.	Hard Drawn Copper & Brass (Vapor Service):	
	3/4" & under	7'-0"
	1"	8'-0"
	1-1/4"	9'-0"
	1-1/2"	10'-0"
	2"	11'-0"
	2-1/2" & larger	12'-0"
5.	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.	

6. Rigid Plastic Pipe:

   a. Space hangers at 4’-0” maximum centers.

7. Installation of hangers shall conform to MSS SP-58 and the applicable Plumbing Code.

END OF SECTION 22 05 29

SECTION 22 05 48 - PLUMBING VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vibration Isolation.

PART 2 - PRODUCTS

2.1 BASIC CONSTRUCTION AND REQUIREMENTS

A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.

C. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

E. All isolators shall be designed or treated for corrosion resistance. All bolts, nuts and washers shall be zinc electroplated. All damage to coatings shall be field repaired with two coats of zinc rich coating.

F. All isolators shall have provision for leveling.

2.2 HANGERS

A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.

2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.

3. Provide hangers with end connections as required for hanging ductwork or piping.

4. Acceptable Manufacturers: Mason "HD" or "WHD", Kinetics "RH", Aeroflex "RHD", Vibration Eliminator Co. “ALH”.

B. Type H2:

1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.

2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.

3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30º arc before contacting the grommet and short circuiting the spring.

4. Provide end connections for hanging ductwork or piping.

5. Acceptable Manufacturers: Mason "30" or "W30", Kinetics "SRH", Amber/Booth "BSRA", Aeroflex “RSH”, Vibration Eliminator Co. “SNC”.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install all products per manufacturer’s recommendations.

B. Provide vibration isolation as indicated on the drawings and as described herein.

C. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

D. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as pipes supported on a strut rack.

3.2 PIPE ISOLATION

A. The first three hangers from vibration-isolated equipment shall be type H1.

B. Provide sufficient piping flexibility for vibrating equipment.

C. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the isolators until the installation is complete and under full operational load.

3.3 VIBRATION ISOLATION SCHEDULE

EQUIPMENT DESIGNATION	BASE TYPE	ISOLATOR TYPE	STATIC DEFLECTION	FLEXIBLE CONNECTIONS
Inline Pump(s)	NA	H2	0.75”	NA

VIBRATION ISOLATION SUBMITTAL FORM

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12
		PROPOSED ISOLATOR							CALCULATIONS		
ITEM SERVED	MIN DEFL (")	TAG	MODEL	MAX LOAD (#)	DEFL @ MAX LOAD (")	DEFL TO SOLID (")	FREE HT (")	Kx/Ky	LOAD (#)	DEFL (")	DEFL RATIO

COLUMN NOTES: Note numbers correspond to the column numbers above.

1. Item served should match designation on the design drawings.
2. List the deflection scheduled or specified in the design documents.
3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.
4. List the manufacturer's complete model designation for the isolator.
5. List the manufacturer's maximum rated load for the isolator.
6. List the isolator deflection at the maximum rated load in column 5.
7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.
8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.
9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.
10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.
11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).
12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.

GENERAL NOTES:

1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.

END OF SECTION 22 05 48

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.

B. ASTM B-1, B-3, and B-8 for copper conductors.

C. ASTM D-1248 for Polyethylene Extrusion Materials, ICEA S-70-547 Weatherproof Resistant Polyethylene Conductors, ICEA S-61-402/NEMA WC5 Thermoplastic Insulated Wire & Cable, ICEA S-95-658/NEMA WC70 Non-Shielded 0 – 2kV Cables.

D. UL 1581 Standard for Electrical Wires, Cables, and Flexible Cords.

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 shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

O.D. of Pipe or insulation	Marker Length	Size of Letters
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
8” to 10”	24”	2-1/2”
Over 10”	32”	3-1/2”

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

B. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

C. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

D. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

E. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

F. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.

G. Tracer Wire:

1. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.

2. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.

3. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.

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 two sets of laminated 8-1/2" x 11" copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

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.

4. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

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 tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.

2. Provide engraved tags at all hydronic 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:

Pipe Service	Lettering Color	Background Color
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
Storm Sewer (Primary and Secondary)	White	Green
All Underground Pipes	Varies	Varies
Tracer Wire	---	Green

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).

C. 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.

1.3 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ASTM B209 - Aluminum and Aluminum-alloy Sheet and Plate.

C. ASTM E84 - Surface Burning Characteristics of Building Materials.

D. NFPA 255 - Surface Burning Characteristics of Building Materials.

E. UL 723 - Surface Burning Characteristics of Building Materials.

F. 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 75ºF; 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 75ºF; moisture resistant, non-combustible; suitable for -100ºF to +900ºF. 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 -40ºF to 150ºF. 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, with a minimum compressive strength of 50 psi. 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:

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

c.	5” to 6"	18" long x 16 gauge
d.	8” to 14"	24" long x 14 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. On exposed piping serving plumbing fixtures, the piping does not need to be insulated if less than four feet in developed length. If piping is longer than four feet in developed length, the piping shall be insulated and have a plastic jacket.

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 60ºF, 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.

3.5 SCHEDULE

	Piping System	Insulation Type/Thickness
A.	Domestic Hot Water & Circulating - Potable and Non-Potable - 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 - Potable and Non-Potable	A / 1”
C.	Storm Drainage (include drain bodies and all piping within the building, except underground)	A / 1”
D.	Plumbing Vents Within 10' from Roof Penetration	A / 1/2”
E.	Insulation Inserts at hangers	C - Match pipe insulation thickness

END OF SECTION 22 07 19

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning is the process for ensuring that the Plumbing System is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Plumbing System from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:

1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
3. Verify O&M documentation submitted is complete. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
5. Furnish labor and material to accomplish plumbing system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

A. Section 01 91 13 – General Commissioning Requirements.

B. Section 01 91 14 – Functional Testing Requirements

C. Division 22 Sections pertaining to the Plumbing Systems included in the commissioning program.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed

access from floor level shall be maintained. Refer to Section 01 91 13 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.

B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.

C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.

D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxP.

E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.

F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the CxP.

3.2 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications

3.4 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION 22 08 00

SECTION 22 09 00 - INSTRUMENTATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Positive Displacement Meters.
B. Pressure Gauge.
C. Pressure Gauge Accessories.
D. Thermometers.
E. Test Plugs.

1.2 REFERENCES

A. ANSI/AWWA C702 - Cold Water Meters - Compound Type.

B. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.

C. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.

D. ASTM E1 - Specification for ASTM Thermometers.

1.3 SUBMITTALS

A. Submit shop drawings per Section 22 05 00. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.1 POSITIVE DISPLACEMENT METERS (LIQUID)

A. AWWA C702 positive displacement disc type suitable for fluid with hermetically sealed register.

B. Provide water meters with bronze case with cast iron bottom cap.

C. Acceptable Manufacturers: Neptune, Badger, or Hersey.

2.2 PRESSURE GAUGES

A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for water or oil application, 1/4" or 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.

B. Acceptable Manufacturers: Ashcroft, Marsh, Marshalltown, Miljoco, Trerice, U.S. Gauge Figure 1901, Weiss, Weksler, Wika.

C. Select gauge range for normal reading near center of gauge.

2.3 PRESSURE GAUGE ACCESSORIES

A. All pressure gauges shall have valves and pressure snubbers.

B. Shutoff Valve: 1/4" ball valve as specified for each piping system.

C. Pressure snubber, brass with 1/4" connections, porous metal type.

2.4 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.

B. Select scales to cover expected range of temperatures.

2.5 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 gauges and 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. Positive Displacement Meters:

1. Install positive displacement meters with shutoff valves on inlet and outlet. Provide full line size valved bypass with globe valve for liquid service meters.

C. Pressure Gauges:

1. Connect pressure gauges to suction and discharge side of all pumps.

2. Provide snubber for each pressure gauge.

D. 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.
E. Storm Drainage 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 B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.

C. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

D. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.

E. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

F. ANSI/ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.

G. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.

H. ANSI/ASTM B32 - Solder Metal.

I. ANSI/ASTM D2466 - PVC Plastic Pipe Fittings, Schedule 40.

J. ANSI/AWS D1.1 - Structural Welding Code.

K. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.

L. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.

M. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

N. ANSI/AWWA C153 – Compact Ductile Iron Fittings 3” through 48”, for Water and Other Liquids.

O. ASME - Boiler and Pressure Vessel Code.

P. ASSE 1003 - Water Pressure Reducing Valves for Domestic Water Supply Systems.

Q. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

R. ASTM A74 - Hub and Spigot Cast Iron Soil Pipe and Fittings.

S. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

T. ASTM A312 – Standard for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

U. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.

V. ASTM A888 - Hubless Cast Iron Soil Pipe and Fittings.

W. ASTM B88 - Seamless Copper Water Tube.

X. ASTM B306 - Copper Drainage Tube (DWV).

Y. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.

Z. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

AA. ASTM C1540 - Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.

BB. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

CC. ASTM D1785 - Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.

DD. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

EE. ASTM D2661 - ABS DWV Pipe & Fittings.

FF. ASTM D2665 - PVC DWV Pipe & Fittings.

GG. ASTM D3033 - Type PSP (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.

HH. ASTM D3034 - Type PSM (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.

II. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.

JJ. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.

KK. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

LL. AWS A5.8 - Brazed Filler Metal.

MM. AWWA C651 - Disinfecting Water Mains.

NN. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.

OO. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.

PP. FM 1680 - Couplings Used in Hubless Cast Iron Systems.

QQ. NFPA 24 - Private Fire Service Mains and Their Appurtenances.

RR. 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 - POTABLE AND NON-POTABLE
HOT WATER - POTABLE AND NON-POTABLE

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. Piping - 4” and Under (Contractor’s Option):

1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.

2. Joints: Mechanical press connection.

3. Fittings: Copper, ANSI B-16.22, with embedded EPDM o-ring, NSF-61.

4. Acceptable Manufacturers: Viega ProPress, Elkhart Xpress, Nibco Press System Fittings and Valving.

D. Shutoff Valves:

1. Butterfly Valves:

a. BF-1:

1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 250°F at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, Stockham LD712-B&3-E, Nibco N200 Series, Milwaukee CL series, Hammond 5200 series.

2. 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.

E. Check Valves:

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

2. CK-14: 2-1/2" thru 12", 200# CWP, double disc wafer type, bronze or iron body, bronze trim, metal-to-metal or Viton seat, 316 SS shaft, Inconel 600 spring. Mission Duo Chek #12HPP (with Inconel springs), Mueller Steam Specialty Co. #71-AHB-K-W, Stockham #WG-961-EPDM or #WG-970-BUNA, Nibco w-920-W.

2.2 COLD WATER - POTABLE AND NON-POTABLE (UNDERGROUND)

A. Design Pressure: 150 psi.
Maximum Design Temperature: 200ºF.

B. Piping - All Sizes:

1. Tubing: Type K annealed 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.

2.3 COMBINATION WATER AND FIRE PROTECTION SERVICE

A. Design Pressure: 200 psi.
Maximum Design Temperature: 150°F.

1. Pipe: Ductile iron pressure water pipe, ANSI/AWWA C151/A21.51, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4.

2. Fittings: Ductile iron, ANSI/AWWA C110/A21.10, or ANSI/AWWA C153/A21.53, 200 psi pressure class, cement-mortar lined per ANSI/AWWA C104/A21.4, push-on joints.

3. Joint: Push-on joint with rubber gasket, ANSI/AWWA C111/A21.11.

2.4 SANITARY DRAINAGE (ABOVE GROUND)
SANITARY VENT (ABOVE GROUND)
STORM DRAINAGE (ABOVE GROUND)

A. Design Pressure: Gravity
Maximum Design Temperature: 180ºF

B. Piping - 1-1/4" through 4":

1. Pipe: Type M hard temper seamless copper drainage tube, ASTM B306.

2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.

3. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.

C. Piping - 1-1/2" through 15":

1. Pipe and Fittings: Standard weight cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888, NSF certified, CISPI trademark.

2. Joints: Heavy duty, neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.

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.

D. 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. Use in walls, chases, or shafts only.

5. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.

E. Vent Flashing: Flash vents with premolded EPDM pipe flashing cones for single-ply membrane roofs.

2.5 SANITARY DRAINAGE (BELOW GROUND - INSIDE BUILDING)
SANITARY VENT (BELOW GROUND - INSIDE BUILDING)
STORM DRAINAGE (BELOW GROUND - INSIDE BUILDING)

A. Design Pressure: Gravity
Maximum Design Temperature: 180ºF

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.

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 ends for Schedule 40 pipe.

4. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.

2.6 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.

C. Check Valves:

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

2.7 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.

2.8 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.

2.9 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 210ºF temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

2.10 BALANCING VALVE

A. Rated for 125 psi working pressure and 250ºF 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. Furnish one meter kit.

D. 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.

E. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.11 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.

2.12 CONNECTIONS BETWEEN DISSIMILAR METALS

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron, steel, and stainless steel connected to each other.

2. Brass, copper, and bronze connected to each other.

3. Brass or bronze valves and specialties connected to steel, iron, or stainless steel in closed systems. Where two brass or bronze items occur together, they shall be connected with brass nipples.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.

2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.

F. Flanged Joints (any size):

1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.

2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.

3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.

4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.

5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.

6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.13 VALVE OPERATORS

A. Provide gear operators for butterfly valves.

2.14 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.

3.2 TESTING PIPING

A. Sanitary Drainage:
Sanitary Vent:
Storm Drainage:

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 - Potable and Non-Potable:
Cold Water - Potable and Non-Potable:
Service 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.

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.

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. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

D. Underground Piping:

1. Install buried water piping outside the building with at least 5 feet of cover.

2. Underground fire protection service piping shall have at least 6-1/2 feet of cover, or as recommended by NFPA 24, whichever is greater.

3. Install thrust blocking and restraints on all underground fire protection service piping per NFPA 24 and as shown on drawings.

4. Lay all underground piping in trenches. Provide and operate pumping equipment to keep trenches free of water.

5. 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.

E. Sanitary and Storm Piping:

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

Pipe Size	Minimum Slope
3" and under	- 0.25" per foot
4" and over	- 0.125" per foot

2. Slope sanitary and storm piping outside the building to meet the invert elevations shown on the drawings and to maintain a minimum velocity of 3 feet per second.

3. Install storm piping in the building with a slope of 0.125" per foot ceilings and 0.25" below grade per foot unless noted otherwise.

4. Install horizontal offset at all connections to roof drains to allow for pipe expansion.

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 45º or 90º 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 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. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install 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.

E. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.

F. 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.

G. 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.

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 470ºF melting point solder. Remove discs and seals during soldering if they are not suitable for 470ºF.

C. Mechanical Press Connection:

1. Copper press fitting shall be made in accordance with the manufacturer’s installation instructions.

2. Fully insert tubing into the fitting and mark tubing.

3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.

4. Joint shall be pressed with a tool approved by the manufacturer.

5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

D. Push-On Joints - Pressure Pipe:

1. Joints shall be single gasket type conforming to ANSI A21.11 "Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings". The bell shall have cast or machined gasket socket recesses, a tapered annular opening and flared socket design to provide deflections up to 5º. Plain spigot ends shall be suitably beveled for easy entry into bell, centering in gasket and compression of gasket.

2. The joint shall be liquid tight under all pressures from vacuum to 350 psig.

3. Furnish sufficient lubricant for a thin coat on each spigot end. Lubricant shall be non-toxic, impart no taste or odor to conveyed liquid, and have no deleterious effect on the rubber gasket. Lubricant shall be of such consistency that it can be easily applied to the pipe in hot and cold weather and shall adhere to either wet or dry pipe.

E. 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.

F. 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.

G. Sleeve Gaskets (No-Hub) (Sanitary and Storm Pipe):

1. Gasket shall be heavy weight class, conforming to ASTM C564.

2. The gasket shall have an internal center stop.

3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.

4. Sleeve gaskets shall be installed 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.

3.11 SERVICE CONNECTIONS

A. Provide new sanitary and/or storm sewer services. Before commencing work check invert elevations needed for sewer connections, confirm inverts and verify these can be properly connected with slope for drainage and cover to avoid freezing.

END OF SECTION 22 10 00

SECTION 22 10 30 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roof and Floor Drains.
B. Cleanouts.
C. Traps.
D. Backflow Preventers.
E. Water Hammer Arresters and Air Chambers.

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. ANSI A112.21.2 - Roof Drains.

C. ASSE 1010 - Water Hammer Arresters.

D. ASSE 1012 - Backflow Preventers with Intermediate Atmospheric Vent.

E. ASSE 1047 - Reduced Pressure Detector Assemblies.

F. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.

G. 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 YARD CLEANOUTS

A. Provide yard cleanouts as shown and specified on the drawings as well as required by code.

B. Cleanout shall be same size as pipe up to 6" and 6" for larger pipes.

2.3 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 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.

2.4 FLOOR DRAINS

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

2.5 ROOF DRAINS

A. Provide roof drains as shown and specified on the drawings as well as required by code.

2.6 BACKFLOW PREVENTERS

A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

2.7 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 -100ºF and 300ºF 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. Install a full size, two-way cleanout within 5 feet of the foundation inside or outside of building.

5. 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.

6. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12” above the finished floor.

E. Yard Cleanouts:

1. Install cleanouts on maximum 90 foot centers (including riser) for pipes 8" and smaller.

2. Extend cleanout to grade. Encase cleanout in 5" thick concrete pad extending 6" beyond cleanout, set low enough not to interfere with lawn mowers.

F. 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.

2. Use alternate sealing method when installing drains in existing floor slabs.

3. Coordinate sloping requirements with the architectural plans and specifications.

G. Roof Drains:

1. Roof drains shall have bearing pans.

2. Provide auxiliary support steel under drains as required to prevent movement of the drain.

3. All roof drains shall have underdeck clamps.

4. Drains in built-up roofing systems shall have a 36" x 36", 3 lb density lead sheet flashing.

H. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.

2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.

3. Install unit between 12" and 60" above finish floor.

END OF SECTION 22 10 30

SECTION 22 11 23 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Domestic Water In-Line Circulators.

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. Domestic hot water pumps shall be suitable for 225ºF water.

F. Motors shall comply with Section 22 05 13.

G. Submitted pump selections must have a diameter impeller that meets or exceeds the scheduled pump. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.

2.2 DOMESTIC WATER IN-LINE CIRCULATORS

A. Provide pumps as specified on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install all products per manufacturer's recommendations.

2. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. In-Line Pump:

1. Support in-line pumps individually so there is no strain on the piping. Install with a minimum of five diameters of straight pipe on pump suction and discharge.

2. 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.

3. 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.

C. Pump without VFD:

1. For pumps not powered by a VFD, trim impeller to meet maximum operating conditions. Coordinate final trimmed diameter with Testing, Adjusting, and Balancing Contractor and Architect/Engineer.

END OF SECTION 22 11 23

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 storm 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.
B. Water Softeners.

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/ASME Section 8D - Pressure Vessels.

C. ANSI Section 21.10.1 or Section ANSI 21.10.3 - Gas Water Heaters Ratings 75,000 BTU per Hour and Less.

D. ANSI/NFPA 30 - Flammable and Combustible Liquids Code.

E. ANSI/NFPA 54 - National Fuel Gas Code.

F. ANSI/NFPA 70 - National Electrical Code.

G. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters.

H. ASSE 1005 - Water Heater Drain Valves, 3/4" Iron Pipe Size.

I. UL 174 - Household Electric 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. Include heat exchanger dimensions, size of tappings, and performance data.

D. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

E. For equipment connected to an electric power source, submit short circuit rating (SCCR) of integrated unit.

F. Submit manufacturer's installation instructions including control and wiring diagrams.

G. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.

H. 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.

C. Conform to ANSI/ASME Section 10 for manufacture of fiber-reinforced plastic pressure vessels.

PART 2 - PRODUCTS

2.1 WATER HEATERS

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

2.2 COMMERCIAL WATER SOFTENER

A. Automatic duplex water softener to remove hardness to no more than 1.0 grains per gallon as determined by an ASTM Standard Soap Test Method.

B. Incoming water contains approximately 17.5 grains per gallon. Obtain a current water sample from the water source serving that will be serving the project and have it analyzed to make sure equipment can perform as designed. Provide report to the Architect/Engineer before providing shop drawings.

C. System designed for 80,000 grains minimum and 120,000 grains per 60 lbs. salt maximum exchange capacities. Water pressure drop not to exceed 15 psi at continuous flow rate of 45 gpm and 25 psi at a peak flow rate of 60 gpm; 120/1/60 power requirements.

D. Softener Tank: Fiberglass reinforced polyester, ASME stamped, designed for a minimum working pressure of 100 psig, hydrostatically tested at 150% of working pressure. Sideshell height to allow a minimum freeboard space of 50% of the mineral bed depth for adequate expansion during backwashing. Softener tank shall not be over 16 inches diameter, 65 inches sideshell height. Tank bottom will be supported with a molded structural base. The top opening will be 4” inches with a threaded connection.

E. Distribution System: Soft water collector and backwash distributor, hub and arm radial or healer lateral type lower distribution system. Distribution shall be covered with a single

layer of washed inorganic media to evenly distribute the service and backwash water and support the mineral bed tank.

F. Brine Tank: Rigid polyethylene or fiberglass with tight fitting cover, size not over 24 inches diameter, 50 inches height, corrosion-free elevated salt platform, float-operated plastic fitted brine valve to control brine withdrawal and freshwater refill. The brine valve shall provide positive shutoff to prevent air from entering the system. Brine eductor shall dilute brine flow to softener. Brine shall be provided with a float-operated shutoff valve to keep the tank from overfilling.

1. Provide initial fill of brine tank with manufacturer recommended salt product. Tank shall be full at time the Owner is given occupancy.

G. Softener Ion Exchange Resin: Virgin, high capacity, standard mesh of sulfonated polystyrene type stable over the entire PH range, with good resistance to bead fracture from attrition or osmotic shock. Minimum exchange capacity of 30,000 grains when regenerated with 15 lbs. of salt per cubic foot. Solid resin, of the proper particle size of 20 to 50 mesh, U.S. standard screen, and will contain no agglomerates, shells, plates, or other shapes to interfere with normal function of water softener. The system shall include 4 cubic feet of exchange resin per vessel and a total of 8 cubic feet of resin for the system.

H. Pipes, Valves and Fittings: Pipe shall be galvanized, standard weight steel, Type L copper, or Schedule 5 stainless steel. Fittings shall be 125 lb. Class malleable iron for steel, Type L for copper, and Schedule 5 for stainless steel. All piping shipped assembled shall be hydrostatically tested for leaks at the factory.

I. Water Testing Equipment: Complete with sample cock installed to obtain samples of effluent water. Furnish a complete test kit for conducting soap tests.

J. Automatic Controls:

1. The main control shall be a fully automatic, top-mounted brass control and sized with 2 inch NPT inlet and outlet connections. The top-mounted main control design will be motor driven, mechanically activated, with five pistons to accomplish the regeneration steps of backwash, brine draw/rinse, fast rinse, and brine refill, in addition to the service position.

2. The main control shall incorporate self-adjusting flow regulators to control the rate of flow and prevent resin loss during backwash, regardless of the system pressure fluctuations between 30 and 120 psig.

3. Valves shall be controlled by integral electronic controls. Controls shall display status of each unit with respect to service and regeneration. Controls for multi-tank systems shall be capable of operating units simultaneously, alternating unit service, or progressively bringing additional units on and off line as needed to maintain flow rates and reduce risk of channeling.

4. Regeneration shall be initiated by time volume harness sensor external device. System shall be programmed so units are unable to regenerate simultaneously.

5. Provide brine reclaim system. During regeneration cycle, a portion of the brine draw/slow rinse cycle waste will be diverted back to the brine tank using specific valve arrangements. Brine reclaim shall be automatically controlled.

6. The unit shall be supplied so that the valve will allow automatic bypass of untreated water during regeneration. The bypass shall be integral to the main control.

7. All control mechanisms shall be enclosed in a UL listed NEMA 3 enclosure. A fully integrated, programmable, microprocessor-driven electronic controller shall be provided to automatically cycle the main control through the regeneration sequence.

8. Each controller shall be provided with dry contacts that will be able to send alarms status signals to the building automation system.

9. Electrical Requirements: Each valve shall be prewired with a plug and cord and an inline breaker to plug into a standard receptacle or wired to a common control panel so a single electrical connection can be provided. 120 volt-single phase. Electric power shall not be needed for manual regeneration. Inlet hydraulic pressure shall be required.

K. Extra Stock:

1. Furnish extra materials as listed below that match products installed and that are packaged and labeled for storage.

a. Provide 120 lbs. additional salt in the same form as the original load. Salt shall be delivered and stored on pallet(s). Locate the pallet(s) per the Owner's direction.

b. Provide one additional gasket for each handhole and manway.

L. Warranty:

1. Provide a standard one-year warranty on the entire unit from the date of final acceptance.

2. Provide a standard two-year warranty on the control valve internal parts, the brine valve and associated parts, and the salt storage container internal components.

3. Provide a standard five-year warranty on the control valve body, fiberglass wound container(s) (if applicable), salt storage container(s) (if applicable), and epoxy lined steel conditioner tank(s) (if applicable).

M. Acceptable Manufacturers: Culligan, Marlo, Hellenbrand, Diamond, Siemens, Watts, Sterling, Avid.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 WATER HEATER INSTALLATION

A. Install water heaters on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 22 05 29.

B. Install water heaters level and plumb, according to drawings, manufacturer's instructions, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. 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.

D. Install gas water heaters according to NFPA 54.

3.3 WATER SOFTENER INSTALLATION

A. Verify connection sizes and piping type with cold water and soft cold water piping. Provide dielectric connection between dissimilar metals. Pressure gauges are required at hard water inlet and soft water outlet of each softener.

B. Provide double check valve backflow preventer on incoming CW service to water softeners that do not use a venturi to siphon brine.

C. Provide system start-up and subsequent service, with stocking of spare parts by authorized dealer or factory trained personnel.

D. Provide complete instructions covering installation and operation of the softening system in booklet form. All components shall be easily identified, in exploded views, by individual part number.

E. Provide six hours of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers shall be included in training.

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 A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

F. ASSE 1002 - Water Closet Flush Tank Ball Cocks.

G. Americans with Disabilities Act (ADA), Title III.

H. The Energy Policy Act (EPAct) of 2005.

I. USGBC - Leadership in Energy and Environmental Design (LEED) Rating System.

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.

8. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8” high lettering saying “Non-Potable Water Not for Human Consumption.” Sign shall have black lettering on a yellow background.

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. 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.

D. 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.

E. 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 ALTERNATES

A. Alternate #1: Revise and extend ductwork serving Storage 1014 to serve Storage 1015. Refer to M1.40 for more information.

B. Alternate #2: Revise and extend ductwork serving Storage 1014 to serve Storage 1015. Revise heating water piping and add a unite heater to serve Storage 1015. Refer to M1.40 and M2.40 for more information.

C. Alternate #3: Revise and extend ductwork serving Storage 1014 to serve Storage 1015 and Storage 1016. Revise heating water piping and add a unite heater to serve Storage 1015. Refer to M1.40 and M2.40 for more information.

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, hydronic 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, IL 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:

Referenced Specification Section	**Submittal Item**
23 05 93	Testing, Adjusting, and Balancing
23 09 00	Controls
23 21 23	HVAC Pumps
23 25 00	Chemical Treatment Systems

Referenced Specification Section	Submittal Item
23 31 01	Fabric Ductwork
23 33 00	Duct Silencers
23 33 00	Fire Dampers
23 34 23	Power Ventilators
23 36 00	Terminal Air Boxes
23 37 00	Grilles, Registers, and Diffusers
23 52 16	Condensing Boilers
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., 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., 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 rooftop unit, pump, exhaust fan, etc.). Use the equipment nomenclature (RTU-1, P-1, EF-1, etc.) on the Schedule of Values.
   b. Each type of small unitary equipment (e.g., 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 (heating water, 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, etc.) listed separately for each unit they serve (RTU-1 supply air ductwork, RTU-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. Commissioning
k. Record drawings
l. 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. Boilers, Burners and Boiler Trim
2. Fire Seal Systems

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.

1.13 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.

1.14 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 23 08 00, and provide all services necessary for compliance with LEED Prerequisite EAp1 and Fundamental Commissioning.

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.
f. Terminal air box reheat coil piping or wiring is complete.
g. Terminal air box control wiring is complete and all control boxes are closed.

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 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 by State Boiler Inspector.

5. Start-up reports on all equipment requiring a factory installation inspection or start-up.

6. 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. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

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 - eight hours.
2. Chemical Treatment System - As defined in Section 23 25 00.
3. Air Handling System(s) - four hours.
4. 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. Color of paint shall be per the Architect.

H. In accordance with LEED EQc4.2: Low-Emitting Materials - Paints and Coatings, all paints and coatings used on the interior of the building must comply with the following criteria:

1. Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.

2. Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L (2 lb./gal) established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

3. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

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.

D. 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 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

a. Minimizing the amount of dust generated.
b. Reducing solvent fumes and VOC emissions.
c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
d. Protect stored on-site and installed absorptive materials from moisture damage.

2. Request that the Owner designate an IAQ representative.

3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.

4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.

5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.

6. Request copies of and follow all of the Owner's IAQ and infection control policies.

7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.

8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.

9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

10. If permanently installed air handlers are used during construction, MERV 8 filtration media must be used to protect each return air grille or opening. The intent of this will be to prevent construction dust and debris from entering any return or supply air ductwork in the facility. All filtration media must be replaced immediately prior to occupancy.

3.12 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, 75% of the construction and demolition debris for this project must be recycled or salvaged.

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 rooftop units operating and balanced.
3. All fans shall be operating and balanced.
4. All pumps and boilers operating and balanced.
5. All miscellaneous mechanical systems (unit heaters, cabinet heaters, etc.) operating.
6. All temperature control systems operating, programmed and calibrated.
7. Pipe insulation complete, pipes labeled and valves tagged.
8. Fire damper and fire/smoke damper access doors labeled in accordance with specifications.

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.

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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. The Building Officials and Code Administrators National Building Code
H. Wisconsin Administrative Code
I. 2003 International Building Code
J. 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, all Contractors 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

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. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.

E. Provide firestopping systems allowing continuous insulation for all insulated pipes.

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

Penetrating Item	UL System No.
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

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

Penetrating Item	UL System No.
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.

G. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.

H. 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 23 05 03

SECTION 23 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 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

A. Refer to the drawings for required electrical characteristics.

B. Design motors for continuous operation in 40ºC 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. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.

G. Each contractor shall set all motors furnished by him.

H. All motors shall have a minimum service factor of 1.15.

I. 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.

J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.

K. Aluminum end housings are not permitted on motors 15 HP or larger.

L. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.

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

A. All motors, unless exempted by EPAct 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:

	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
HP	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
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0
25.0	93.0	93.6	91.7	93.0	93.6	91.7
30.0	93.6	94.1	91.7	93.0	93.6	91.7
40.0	94.1	94.1	92.4	94.1	94.1	92.4

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

2.3 MOTORS ON VARIABLE FREQUENCY DRIVES

A. All motors driven by VFDs shall be premium efficiency type.

B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.

C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.

D. All 460 volt motors 5 HP and larger controlled by VFDs shall be equipped with an alternate discharge path, such as a shaft grounding ring or grounding brush, to divert adverse shaft currents from the motor bearings on the drive end of the motor shaft. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.

2.4 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.

2.5 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor responsible for motor shall also be responsible for replacement sheaves. Coordinate with testing and balancing of the equipment.

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.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION 23 05 13

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 PIPE HANGERS AND SUPPORTS

A. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58.

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. Ferrous hot piping 2-1/2 inches and larger shall have steel saddles tack welded to the pipe at each support at a depth not less than the specified insulation. Factory fabricated inserts may be used.

Acceptable Products:

Anvil -	Fig. 160, 161, 162, 163, 164, 165
Cooper/B-Line -	Fig. 3160, 3161, 3162, 3163, 3164, 3165
Erico -	Model 630, 631, 632, 633, 634, 635
Nibco/Tolco -	Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4

D. On all insulated piping, provide a semi-cylindrical metallic shield and fire resistant vapor barrier jacket.

E. 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

F. 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 take-off locations.

Acceptable Products:

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

G. Hangers in direct contact with copper pipe shall be coated with plastic with appropriate temperature range. HYDRA-ZORB clamps are permitted for this application for bare pipes within their temperature limits of -65°F to +275°F.

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

1. Clevis Type:
   Service: Bare Metal Pipe
   Insulated Cold Pipe
   Insulated Hot Pipe - 3 inches & Smaller

Acceptable Products:	Bare Steel or Insulated Pipe	Bare Copper Pipe
Anvil	Fig. 260	
Cooper/B-Line	Fig. 3100	Fig. B3100C
Erico	Model 400	
Nibco/Tolco	Fig. 1	Fig. 81PVC

2. Roller Type:
Service: Insulated Hot Pipe - 4 inches and Larger

Acceptable Products:	4" through 6"	8" and Above
Anvil	Fig. 181, 271	Fig. 171, 271
Cooper/B-Line	Fig. 3110, 3117	Fig. 3114, 3117
Erico	Model 610	Model 605
Nibco/Tolco	Fig. 324, 327	Fig. 322, 327

3. Adjustable Swivel Ring Type:
Service: Bare Metal Pipe - 4 inches and Smaller

Acceptable Products:	Bare Steel Pipe	Bare Copper Pipe
Anvil	Fig. 69	
Cooper/B-Line	Fig. B3170NF	Fig. B3170CTC
Erico	Model FCN	102A0 Series
Nibco/Tolco	Fig. 200	Fig. 203

I. 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.

2. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

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

1. Clamp Type:
Service: Bare Metal Pipe
Insulated Cold Pipe
Insulated Hot Pipe - 3 inches and smaller

a. Clamps in direct contact with copper pipe shall be plastic coated.

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

Acceptable Products:	Bare Steel or Insulated Pipe	Bare Copper Pipe
Unistrut	Fig. P1100 or P2500	
Cooper/B-Line	Fig. B2000 or B2400	Fig. BVT
Nibco/Tolco	Fig. A-14 or 2STR	

2. Roller Type:
Service: Insulated Hot Pipe - 4 inches and larger.

Acceptable Products:	4" through 6"
Unistrut	Fig. P2474
Cooper/B-Line	Fig. B218
Nibco/Tolco	Fig. ROL-12

K. 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.

L. 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.

M. 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 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.

2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).

2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a “dirt-trap”.

3. Concrete materials and workmanship required for the Contractor's work shall be provided by him. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6”x6”, W1.4-W1.4

welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.

4. Equipment requiring bases is as follows:

   a. Boiler
   b. Chemical Feed Equipment
   c. Expansion Tank
   d. Pump
   e. Bypass Pot Feeder

C. Equipment Roof Support (Curbs and Rails):

1. Rooftop equipment such as packaged air handling units 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. 24" 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 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
   b. Rooftop Units
   c. Exhaust Fans

D. 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 aluminum 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).

E. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.

2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

F. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.

2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.

3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Coordinate all openings with other Contractors.

B. 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.

C. 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.

D. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.5 ROOF PENETRATIONS

A. Seal pipes with surface temperature below 150ºF 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 60ºF and 150ºF. Seal outdoor insulation edges watertight.

2.6 SLEEVES AND LINTELS

A. 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.

J. Wall Seals ("Link-Seals"):

1. Where shown on the drawings, pipes passing through walls, ceilings, or floors shall have their annular space (sleeve or drilled hole - not tapered hole made with knockout plug) sealed by properly sized sealing elements consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.

2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve. If piping carries only fluids below 120ºF, sleeves may be thermoplastic with integral water seal and textured surface.

3. Sleeves shall be at least 2 pipe sizes larger than the pipes.

4. Pressure shall be maintained by stainless steel bolts and other parts. Pressure plates may be of composite material for Models S and OS.

5. Sealing element shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40ºF to 250ºF

6. Acceptable Manufacturers: Thunderline Corporation "Link-Seals", O-Z/Gedney Company, Calpico, Inc., Innerlynx, or Metraflex Company (cold service only).

2.7 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.

2.8 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.

2.9 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.

2.10 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. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.

3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.

4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.

5. 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. 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.

F. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

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

	Pipe Material	Maximum Spacing
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.	Steel (Std. Weight or Heavier – Vapor Service):	
	1-1/4" and under	9'-0"
	1-1/2"	12'-0"
	2" & larger	12'-0"
3.	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"
	4"	12'-0"
4.	Hard Drawn Copper & Brass (Vapor Service):	
	3/4" & under	7'-0"
	1"	8'-0"
	1-1/4"	9'-0"
	1-1/2"	10'-0"
	2"	11'-0"
	2-1/2" & larger	12'-0"

5. Installation of hangers shall conform to MSS SP-58.

END OF SECTION 23 05 29

SECTION 23 05 48 - HVAC VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vibration Isolation.
B. Flexible Connectors.

PART 2 - PRODUCTS

2.1 BASIC CONSTRUCTION AND REQUIREMENT

A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection [e.g., 3" for 2" calculated deflection]. The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.

C. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

E. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.

F. All isolators, except M1, shall have provision for leveling.

2.2 MOUNTINGS

A. Type M2:

1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.

2. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.

3. All units shall have bolt holes and be bolted down.

4. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.

5. Acceptable Manufacturers: Mason Industries "ND" or "DNR", Amber/Booth "RVD", Kinetics "RD", Vibration Mountings and Controls "RD", Vibration Eliminator Co. “T22” or “T44”.

B. Type M3:

1. Free standing, laterally stable spring isolators without housings and complete with 1/4" neoprene friction pads.

2. Units shall have bolt holes but need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators. Bolt holes shall not be within the springs.

3. All mountings shall have leveling bolts.

4. Acceptable Manufacturers: Mason "SLFH", Kinetics "FDS", Amber/Booth "SW-3, 4", 5"or 6", Vibration Eliminator Co. "OST".

2.3 HANGERS

A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.

2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.

3. Provide hangers with end connections as required for hanging ductwork or piping.

4. Acceptable Manufacturers: Mason "HD" or "WHD", Kinetics "RH", Aeroflex "RHD", Vibration Eliminator Co. "ALH".

B. Type H2:

1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.

2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.

3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30º arc before contacting the grommet and short circuiting the spring.

4. Provide end connections for hanging ductwork or piping.

5. Acceptable Manufacturers: Mason "30" or "W30", Kinetics "SRH", Amber/Booth "BSRA", Aeroflex "RSH", Vibration Eliminator Co. "SNC".

2.4 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

A. Type FC1:

1. Spherical flexible connectors with multiple plies of nylon tire cord fabric and either EPDM or molded and cured neoprene. Outdoor units shall be EPDM.

2. Steel aircraft cables or threaded steel rods shall be used to prevent excess elongation.

3. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer.

4. Connectors up to 2" size may have threaded ends.

5. Connectors 2-1/2" and over shall have floating steel flanges recessed to lock raised face neoprene flanges.

6. All connectors shall be rated for a minimum working pressure of 150 psi at 200ºF.

7. Acceptable Manufacturer: Metraflex "Double Cable-Sphere", Minnesota Flex Corp., Mercer “200 Series”, Twin City Hose “MS2”.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install all products per manufacturer’s recommendations.

B. Provide vibration isolation as indicated on the drawings and as described herein.

C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.

D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.

F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

3.2 PIPE ISOLATION

A. The first three hangers from vibration-isolated equipment shall be type H1.

B. Where piping is floor-supported, use M2 instead of H1 and M3 instead of H2.

C. Install flexible connectors in all piping connected to vibration producing equipment. This includes all fans, base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.

D. Use Type FC1 where pressures are lower than 150 psi, temperatures are below 220ºF, and the fluid handled is compatible with neoprene and EPDM.

E. Provide sufficient piping flexibility for vibrating refrigerant equipment, or furnish flexible connectors with appropriate temperature and pressure ratings.

F. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the

isolators until the installation is complete and under full operational load. Hanger H3 and Mounting M4 may be used instead of other products for this purpose.

G. Support piping to prevent extension of flexible connectors.

3.3 VIBRATION ISOLATION OF DUCTWORK

A. The first three hangers on all fan systems with static pressure greater than 1.0" shall be Type H2 with 0.75" minimum static deflection. All other hangers supporting ductwork within 50' of and connected to vibration-isolated equipment shall be Type H1 with at least 0.20".

B. Provide flexible duct connections as described in Section 23 33 00 at all fan inlets and outlets and on the mechanical room side of all locations where ducts penetrate mechanical room walls.

3.4 VIBRATION ISOLATION SCHEDULE

EQUIPMENT DESIGNATION	**BASE TYPE**	**ISOLATOR TYPE**	**STATIC DEFLECTION**	**FLEXIBLE CONNECTIONS**
Inline Pump(s)	NA	M3 or H2	1.5”	NA
Boilers	NA	NA	NA	FC-1
Packaged HVAC Unit (>15 HP, <4” static pressure)	NA	M3 or H2	Refer to ASHRAE Table	Per Section 23 33 00

Note 1: RTU internal fan isolation shall be determined by RTU manufacturer. Isolation selected shall be a minimum of 98% efficient at scheduled CFM and static pressure.

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12
		PROPOSED ISOLATOR							CALCULATIONS		
ITEM SERVED	MIN DEFL (")	TAG	MODEL	MAX LOAD (#)	DEFL @ MAX LOAD (")	DEFL TO SOLID (")	FREE HT (")	Kx/Ky	LOAD (#)	DEFL (")	DEFL RATIO

COLUMN NOTES: Note numbers correspond to the column numbers above.

1. Item served should match designation on the design drawings.
2. List the deflection scheduled or specified in the design documents.
3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.
4. List the manufacturer's complete model designation for the isolator.
5. List the manufacturer's maximum rated load for the isolator.
6. List the isolator deflection at the maximum rated load in column 5.
7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.
8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.
9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.
10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.
11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).
12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.

GENERAL NOTES:

1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.

END OF SECTION 23 05 48

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 shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

O.D. of Pipe or insulation	Marker Length	Size of Letters
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”
8” to 10”	24”	2-1/2”

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

B. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

C. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

D. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

E. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

F. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.

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. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.

4. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.

5. Number all tags and show the service of the pipe.

6. Provide two sets of laminated 8-1/2" x 11" copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

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.

4. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

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 tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.

2. Fasten nameplates or 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 tags at all hydronic system make-up water meters.

3.2 SCHEDULE

A. Pipes to be marked:

Pipe Service	Lettering Color	Background Color
Heating Water Supply	Black	Yellow
Heating Water Return	Black	Yellow
Pumped Condensate	Black	Yellow
Condensate Drain	Black	Yellow
Natural Gas	Black	Yellow
All Underground Pipes	Varies	Varies
Refrigerant (Liquid, Suction or Hot Gas)	Black	Yellow

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.

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 four (4) certified copies of test reports to the Architect/Engineer for approval in soft cover, 3-hole binder manuals, with cover identification. 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. ± 10% of scheduled values:

1. Adjust air inlets and outlets to ± 10% of scheduled values.

2. Adjust piping systems to ± 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.

E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. 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 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.

4.2 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.

E. Air Terminal Unit (Terminal Air Box) Data:

1. General Requirements:
   a. Drawing symbol.
   b. Location.
   c. Manufacturer and model.
   d. Size.
   e. Type: constant, variable, single, dual duct.
2. Flow Rate:
   a. Cooling maximum flow rate (cfm): specified and actual.
   b. Heating maximum flow rate (cfm): specified and actual.
   c. Minimum flow rate (cfm): specified and actual.
   d. Water flow rate (gpm): specified and actual.
3. Temperature:
   a. Entering air temperature: specified and actual.
   b. Leaving air temperature (in heating mode): specified and actual.
   c. Entering water temperature: specified and actual.
   d. Leaving water temperature: specified and actual.
4. Pressure Drop and Pressure:
   a. Inlet static pressure during testing (maximum and minimum).
   b. Coil air pressure drop: specified and actual.
   c. Water pressure drop: specified and actual.

F. Air Flow Measuring Station:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Size.
6. Flow rate (cfm): specified and actual.
7. Pressure drop: specified and actual.

G. Fire, Smoke, and Fire/Smoke Dampers:

1. Damper ID #.
2. System identification.
3. Type.
4. Size.
5. U.L. assembly number.
6. Location of damper and access door.
7. Fusible link temperature rating.
8. Manufacturer and model.
9. Operation pass/fail/reset.

H. LEED Indoor Chemical and Pollution Exhaust Verification

1. In accordance with LEED EQp2 and EQc5, negative pressurization must be maintained in the following rooms:

   a. Housekeeping Closets
   b. Laundry Rooms
   c. Copy Rooms
   d. Printing Rooms

2. Verify that each room operates at a negative pressure (compared to each adjacent area and adjacent vertical chase) of at least -0.004 in. w.c. and an average of -0.020 in. w.c. when the doors to the room are closed.

3. Performance of rooms' differential air pressures must be verified by conducting 15 minutes of measurements, with a minimum of 1 measurement every 10 seconds.

a. This test must be conducted for each adjacent area and adjacent vertical chase with the doors of the room closed.

I. LEED Air Contaminant Flushout

1. In accordance with LEED EQc3.2 Option 1, the Contractor shall perform a building flushout of air contaminants. The flushout must follow either Path 1 or Path 2 as outlined below. The Contractor shall coordinate with all other trades, the Construction Manager, and the Owner to determine the time required and scheduling for the flushout. The Contractor shall keep records documenting the flushout process and submit them to the Architect and Engineer when the process is complete.

a. Path 1 - Pre-Occupancy Flushout: After construction is complete and prior to occupancy and with all interior finishes installed, install new filtration media and perform a flushout by supplying a total air volume of 14,000 cubic feet. of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60°F and relative humidity no higher than 60%.

b. Path 2 - Occupied Flushout: The space may be occupied after delivering a minimum of 3,500 cubic feet. of outdoor air per square foot of floor area (in accordance with the requirements listed in Path 1). Once the space is occupied, it must be ventilated at a minimum rate of 0.30 CFM/SF of outdoor air or the scheduled design minimum outside airflow rate, whichever is greater. During each day of the flushout period, ventilation must begin a minimum of 3 hours prior to occupancy and continue during occupancy. These conditions must be maintained until a total of 14,000 cubic feet. per square foot of outside air has been delivered to the space.

4.3 HEATING SYSTEMS

A. Pump Data (Heating water Loop Pumps):

1. Existing drawing symbol or equipment TAG
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: Operating and shutoff.
8. Discharge Pressure: Operating and shutoff.
9. Final frequency of motor at maximum flow rate (on pumps driven by VFD).

B. Electric Motors (Associated Heating Water Loop Pump 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.

C. Heating Coils:

1. General Requirements:
   a. Drawing symbol.
   b. Service.
   c. Location.
   d. Manufacturer and model.
   e. Size.
2. Flow Rate:
   a. Flow rate (cfm): specified and actual.
   b. Water flow rate: 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. Pressure Drop and Pressure:
   a. Air pressure drop: specified and actual.
   b. Steam pressure after valve: specified and actual.
   c. Water pressure drop: specified and actual.
5. Energy:
   a. Air Btuh (cfm x temp rise x 1.09).
   b. Water Btuh (gpm x temp drop x 500). Repeat tests if not within 10% of air Btuh.

D. 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.

E. Hot Water Boiler:

1. General Requirements:
   a. Drawing symbol.
   b. Service.
   c. Location.
   d. Manufacturer, model, and identification number.
   e. Control setting: specified and actual.
2. Temperature:
   a. Entering water temperature: specified and actual.
   b. Leaving water temperature: specified and actual.
3. Flow Rate:
   a. Flow rate (gpm): specified and actual.
4. Pressure Drop and Pressure:
   a. Pressure Drop: specified and actual.
5. Energy:
   a. Rating (Btuh).
   b. Measured output (Btuh).

4.4 PLUMBING SYSTEMS

A. Pump Data: **[SPECIFIER: Use for domestic water booster systems and for hot water circulation systems. Include notes on drawings indicating balancing valve flow rates for each balancing valve in the hot water circulation system.]**

1. Drawing symbol.
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: operating and shutoff.
8. Discharge Pressure: operating and shutoff.

B. 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 for each phase.

C. Balancing Valve:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.

D. Gas Fired Water Heater:

1. Drawing symbol.
2. Service.
3. Location.

4. Manufacturer and model.
5. Capacity (Btuh): specified, nameplate, and actual.
6. Entering water temperature: specified and actual.
7. Leaving water temperature: specified and actual.
8. Pressure Drop: specified and actual.
9. Control Setting: specified and actual.

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. ASTM E2336-04 – Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.

H. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

I. NFPA 96 - Standard for the Installation of Equipment for Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.

J. NFPA 255 - Surface Burning Characteristics of Building Materials.

K. UL - XHEZ - Through Penetration Firestop Systems.

L. UL 263 - Full Scale External Fire Tests with Hose Stream.

M. UL 723 - Surface Burning Characteristics of Building Materials.

N. 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 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.

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 (Indoor 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 needed 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 Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK facing tape.

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.

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. Preformed Fiberglass Acoustical Liner, Rigid - Type G:

1. Cut and secure duct liner inside duct.

2. Install insulation pins or adhesives 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 07 16 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment Insulation.
B. Equipment Insulation Finishes.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in 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).

C. 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.

1.3 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.

C. ANSI/ASTM C921 – Properties of Jacketing Materials for Thermal Insulation

D. ANSI/ASTM D1668 – Glass Fabric for Waterproofing

E. ASTM E84 - Surface Burning Characteristics of Building Materials.

F. National Commercial & Industrial Insulation Standards - 1999 Edition - as published by Midwest Insulation Contractors Association and endorsed by National Insulation Contractors Association.

G. NFPA 255 - Surface Burning Characteristics of Building Materials.

H. UL 723 - Surface Burning Characteristics of Building Materials.

PART 2 - PRODUCTS

2.1 INSULATION

A. Type C: Glass Fiber Blanket; ANSI/ASTM C612; 0.40 maximum 'K' value at 300ºF; 2.5 lb/cu ft.; suitable to 850ºF, with all service jacket (ASJ) vapor retarder jacket having 25/50

flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).

2.2 INSULATION FINISHES

A. Type 1: Glass Fabric; ASTM D1668, woven glass fabric with two coats of mastic approved for insulation type. Use vapor barrier mastics that are approved for both indoor and outdoor use on insulation systems covering surfaces having temperatures less than 70°F and having maximum 0.013 perms/inch rating at 0.043 inch dry-film thickness when tested in accordance with ASTM E-96 Procedure B (Foster 30-80 or approved equivalent). Use breather mastics that are approved for both indoor and outdoor use on insulation systems covering surfaces having temperatures 70°F or greater (Foster 35-00 or approved equivalent).

B. Type 2: All Service Jacket; ASTM C921; Factory or Field Applied; Kraft paper bonded to aluminum foil reinforced with glass fiber; Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Seal all joints with manufacturer approved tape and adhesive to maintain vapor barrier. Indoor use only, if used outdoors add type 4 finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all materials per manufacturer's instructions, codes and industry standards.

B. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

C. Do not insulate factory insulated equipment.

D. Apply insulation as close as possible to equipment by grooving, scoring, and bevelling insulation. Secure to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier mastic.

F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.

G. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning; install specially fabricated removable insulation sections. Covers shall have mechanical fasteners and be reusable.

H. Install 26 gauge galvanized sheet metal corner protection angles where insulation extends to the floor. Minimum 2" coverage of insulation.

I. Insulate all equipment surfaces that are not factory insulated and are intended to operate below 60°F and/or above 100°F. Verify insulation type and thickness with equipment manufacturer and Architect/Engineer.

J. Insulate all supports on equipment operating below ambient temperature.

3.2 INSULATION

A. Type C:

1. Apply with edges tightly butted and joints staggered.

2. Secure with welded pins and washers, 4” from each edge and 16” on center, or 1/2" x 0.015” galvanized steel bands, 12” on center.

3.3 SCHEDULE

Equipment	Insulation Type	Insulation Thickness	Insulation Finish
A. Heating Water Air Separator	C	2"	1 or 2

END OF SECTION 23 07 16

SECTION 23 07 19 - HVAC 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).

C. 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.

1.3 REFERENCES

A. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ANSI/ASTM C534 - Elastomeric Foam Insulation.

C. ANSI/ASTM C547 - Mineral Fiber Preformed Pipe Insulation.

D. ANSI/ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

E. ASTM C578 - Preformed Cellular Polystyrene Thermal Insulation.

F. ASTM E84 - Surface Burning Characteristics of Building Materials.

G. NFPA 255 - Surface Burning Characteristics of Building Materials.

H. UL 723 - Surface Burning Characteristics of Building Materials.

I. 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 75ºF; 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 B: Elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75ºF, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 3/4" thick per layer where multiple layers are specified.

C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.35 maximum 'K' value at 75ºF; moisture resistant, non-combustible; suitable for -100ºF to +900ºF. 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 -40ºF to 150ºF. 25/50 maximum flame spread/smoke developed.

2.4 REFRIGERANT PIPE COUPLING

A. Insulation Coupling: Molded thermoplastic ASTM D1525, -65ºF to 275ºF, sizes up to 4-1/8” O.D., and receive insulation thickness up to 1”. Suitable for use indoors or outdoors with UV stabilizers.

B. Acceptable Manufacturers: Klo-Shure or equal.

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, with a minimum compressive strength of 50 psi. 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:

	Pipe Size	Shield Size
a.	1/2" to 3”	12" long x 18 gauge
b.	4"	12" long x 16 gauge
c.	5” to 6"	18" long x 16 gauge
d.	8” to 14"	24" long x 14 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.

B. 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.

C. Refrigerant Piping:

1. On refrigerant piping (25°F and above) and **not** required to meet the 25/50 flame/smoke, provide at each strut or clevis support an insulation coupling to support pipe and to accept insulation thickness of adjoining insulation, to prevent insulation from sagging and crushing. The coupling shall be suitable for planned temperatures, use with specified pipe material, and shall be a 360°, one-piece cylindrical segment. Use mechanical fasteners where coupling cannot be installed on pipe during installation. Contractor shall apply adhesive to ends of insulation entering insulation coupling to maintain vapor barrier.

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 60ºF, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.

2. Self-seal insulation may be used on pipes operating below 170ºF.

C. 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.

3.5 SCHEDULE

Piping System	Insulation Type/Thickness
A. Heating Water Supply & Return	
Under 1-1/2"	A / 1-1/2”
1-1/2" and above	A / 2"
B. Underground Heating Water Supply & Return	C / 1”
C. Refrig. Hot Gas Lines	
Up to 1-1/4”	B / 1/2”
D. Refrig. Suction Lines (25ºF & Above)	
Up to 1-1/2”	B / 1-1/2”
E. Insulation Inserts at hangers	C - Match pipe insulation thickness

END OF SECTION 23 07 19

SECTION 23 08 00 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning is the process for ensuring that the HVAC System is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the HVAC System from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:

1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
3. Verify O&M documentation submitted is complete. Provide required documentation and information to the General Contractor. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
5. Furnish labor and material to accomplish HVAC system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

A. Section 01 91 13 – General Commissioning Requirements

B. Section 01 91 14 – Functional Testing Requirements

C. Division 23 Sections pertaining to the HVAC Systems included in the commissioning program.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed

access from floor level shall be maintained. Refer to Section 01 9113 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.

B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. All of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.

C. Installation Certification Form (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.

D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the checklists provided by the CxP.

E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.

F. Completed Installation Certification Forms along with completed respective manufacturer's Start-up forms and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the CxP. The CxP will not schedule any testing until all of these documents have been received, reviewed, and approved.

3.2 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.4 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing
   1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 91 14 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION 23 08 00

SECTION 23 08 01 - COMMISSIONING OF BUILDING CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning is the process for ensuring that the Building Automation System (BAS) is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the BAS from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:
   1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
   2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
   3. Verify O&M documentation submitted is complete. Provide required documentation and information to the General Contractor. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
   4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
   5. Furnish labor and material to accomplish Building Automation System commissioning and systems' testing as specified herein and other related sections.

C. Primary elements of BAS Commissioning during the construction, acceptance and warranty phases of the project shall include:
   1. BAS and equipment testing and start-up.
   2. Verification of complete and thorough installation of BAS and equipment.
   3. BAS performance verification.
   4. Sensor checkout and calibration.
   5. Control valve leak check.
   6. Valve/Damper Stroke Setup and Check.
   7. Verification of BAS system and equipment graphics and proper representation and point mapping and display.
   8. BAS Demonstration.
   9. BAS Acceptance Period.
   10. Trend logs and graphs.
   11. Functional testing of BAS.
   12. Documentation of tests, procedures, and installations.
   13. Provision and coordination of BAS training.
   14. Documentation of BAS Operation and Maintenance materials.
   15. Warranty Phase BAS Opposite Season Trending and Evaluation.

1.2 RELATED SECTIONS

A. Section 01 91 13 – General Commissioning Requirements

B. Section 01 91 14 – Functional Testing Requirements

C. Division 23 Sections pertaining to the Building Automation Systems included in the commissioning program.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the Commissioning Provider, in addition to the copies required by the Owner and Design Professional.

B. Point-to-Point verification documentation shall be submitted to the CxP prior to scheduling the final functional performance test of the BAS system.

1.4 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

D. BAS contractor shall provide a portable operator's terminal or hand held device to facilitate the checking of sensor calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the thermostat or the box.

PART 3 - EXECUTION

3.1 COMMISSIONING PROCEDURES AND REQUIREMENTS

A. The Contractor is responsible for field calibration of all sensors and devices.

B. Through the commissioning process, the Contractor shall, to the satisfaction of the CxP:

1. Verify the installation, operation and functional performance of BAS systems hardware and software for compliance with design intent and the Contract Documents.

2. Document the data generated by tests and inspections. This documentation shall primarily be done in the ICF form and the prefunctional performance test.
3. Verify accuracy and logical organization of Operation and Maintenance Manuals, as-built control sequences, and as-built program logic and setpoints.

C. A complete static and dynamic commissioning test program shall be implemented for all hardware and software points, all BAS panels and for all devices by the Contractor.
1. Static tests: Commissioning tests shall consist of a full range of static tests carried out to verify that all hardware points, software, panels, transducers, all devices and other components, function in accordance with the specifications.
2. Dynamic tests: System performance shall be checked under dynamic conditions that simulate varying load and operating modes, including pre-conditioning, start-up, normal operating, emergency and fail-safe modes, shut-down interlocks and lock-outs defined in the Control Sequences.

D. The Contractor shall provide all commissioning test equipment required.

E. The CxP shall be given written notice and all required pre-requisite documentation at least seven (7) days in advance of the dates of all tests. The BAS graphics package must have been completed and must be available for testing. Detail the locations and parts of system(s) being tested, the test procedures proposed and the anticipated results. The CxP shall witness testing to the level necessary to ensure testing protocols are acceptable and being followed.

F. Acceptance by the CxP of test procedures outlined in this Section shall not relieve the Contractor of responsibility for the complete system meeting the requirements of these Specifications after installation.

G. Final functional performance tests shall be performed for the BAS system as a whole and witnessed by the CxP.
1. Upon complete installation of the BAS system, the Contractor shall start up the system and perform all necessary testing and run diagnostics to ensure proper operation.
2. Pertinent sections of the Installation Certification Form (ICF) and a documented prefunctional performance test for the system shall be completed by the contractor prior to scheduling of the acceptance test.
3. A functional performance test, witnessed by the CxP, or designated representative, shall be performed for each system that includes integrated automation.

H. All testing, including the final functional performance test, shall be completed prior to substantial completion. If any check or test cannot be accomplished for seasonal reasons, lack of occupancy, or for other reasons, this fact shall be noted along with an indication of when the test shall be rescheduled.

3.2 STATIC COMMISSIONING OF THE INPUT AND OUTPUT HARDWARE

The Contractor shall complete a point-to-point check of the BAS system and provide documentation of same. The point-to-point checks and field sensor/device calibration shall be completed during the Contractor's own testing and verification. The documentation of field calibration of sensors and devices shall be recorded in the Installation Certification Form (ICF) specific system/equipment/component. Factory calibration of sensors shall not be accepted in lieu of field calibration. The completed point-to-point documentation shall then be submitted to the CxP for review and approval. The CxP shall repeat a random sample (20% minimum) of the point-to-point checks during the commissioning process to corroborate accuracy of the documentation. The Contractor shall be present on site with test equipment to repeat a random sample of the point-to-point checks and field calibrations. The procedures shall include the following:

1. Binary Input (BI) :
   a. BI status shall be verified at the Front End, local BAS control panel and equipment location for ON status and OFF status.

b. All binary alarm inputs shall be proven using actual conditions where possible or be jumpered for testing with approval by the CxP at the field device to test for correct notification at the equipment location, local BAS control panel and front end.

2. Binary Output (BO)
   a. Status shall be verified at the equipment location. Verification at the Front End shall be completed for ON status, OFF status, software DISABLE indicator and OVERRIDDEN indicator.
3. Analog Input (AI)
   a. All temperature sensors shall be verified by conducting an equivalence test using a digital hand-held meter with equal or better accuracy.
   b. Selected temperature sensors chosen by the CxP shall be verified by spraying with a "cold-spray" or other means to ensure response and to test the low temperature alarm condition.
   c. All pressure sensing devices and analog output feedback shall be verified using a device with equal or better accuracy to ensure correct calibration. Calibration must be per Manufacturers' recommendations and to the CxP's satisfaction.
   d. All humidity sensing devices must be verified using a psychrometer with equal or better accuracy to ensure correct calibration. Calibration shall be per Manufacturer's recommendations and to the CxP's satisfaction.
   e. All CTs shall be set to accurately reflect motor status.
   f. All other sensing devices shall be verified using an appropriate device with equal accuracy or better to ensure correct calibration. Calibration shall be per Manufacturer's recommendations and to the CxP's satisfaction.
   g. Adjust span on feedback points so the analog input matches the end device output.
4. Analog Output (AO)
   a. AO's shall be tested by sending a command from the front end to incrementally stroke the field device from full CLOSED to full OPEN and measuring the signal at the field device. The increments of the test shall be no larger than 10% of output span.
   b. The AO feedback requirement shall also be tested by failing the field device and verifying that the alarm registers.
   c. Each output shall be exercised over the full output capability of the panel.
   d. Field device hysteresis shall be measured at a minimum of three output levels for each direction of travel. Output increments shall not exceed 2% of span for this test.

3.3 STATIC COMMISSIONING OF THE BAS SYSTEM SOFTWARE

A. The CxP shall review the final versions of all BAS system software to ensure that the software complies with the Control Sequences in every respect. The Contractor shall provide assistance and technical manuals as required.

B. The Contractor and the CxP shall commission the Front End graphics and reports.

3.4 STATIC COMMISSIONING OF THE BAS SYSTEM PANEL NETWORK AND DEVICES

A. Each BAS panel and/or controller shall be checked for compliance with standalone and fail-safe requirements, proper grounding and other features. All features listed in Section 23 09 00 shall be checked and verified by the Contractor in the presence of the CxP. Panels that do not pass the standalone tests shall be replaced at no cost to the Owner. In this context, "standalone" means that the panel, with the network cable disconnected, shall accurately maintain reference time, continue trending data, maintain communications with any panels connected to it and control the equipment connected to the panel.

3.5 DYNAMIC COMMISSIONING OF THE WORK AS A WHOLE

A. Functional Performance Testing

1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing qualified manufacturer's representatives to demonstrate the operational capabilities of the integrated automation systems.

B. Seven(7) Day Acceptance Test

1. The Seven (7) Day Acceptance Test shall be scheduled after successful completion of the functional performance test. This test shall occur after substantial completion to limit the contractor activities while the test is being performed.
2. With all points enabled and automatically controlled, all systems and associated programs shall operate for seven (7) consecutive days on history/trend logs to verify all types of conditions that occurred in the period.
3. All history/trend logs shall be set up by the Contractor and shall be submitted to the CxP for review and approval.
4. During the Acceptance Test period, the CxP may generate various failure scenarios to ensure the repeatable and acceptable recovery scenarios are achieved. This will focus primarily on the production areas of the facility.
5. The Contractor shall provide a minimum of seven days' worth of trend data to verify that the following functions:
    a. Systems operate in accordance with sequence of operations without manual intervention
    b. Reset schedules for setpoints are met
    c. Control loop stability without hunting
    d. Acceptable failure and recovery scenarios so as to maintain pressure cascades
    e. Contractor shall provide trend data at intervals and duration specified by the CxP at the start of the acceptance test period to determine that the above Control Sequences functions perform to his satisfaction.
6. This condition of the commissioning process is met when all alarms and system values are appropriate for the defined Control Sequences. The Acceptance Test is considered a "PASS" if no unexpected outcomes are generated during the period. If unexpected outcomes do occur the test shall be considered a "FAIL". Depending on the criticality of the unexpected outcome, the contractor may be allowed to continue testing after modifications are made to complete the test period or may be required to start the acceptance test over.

3.6 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND EVALUATION:

A. Opposite Season Evaluation: Within 6 months of completion of the Acceptance Phase, CxP shall schedule and conduct Opposite Season functional performance evaluation. BAS contractor shall participate in this evaluation and possible testing, if required, and remedy any deficiencies identified.

3.7 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.8 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

END OF SECTION 23 08 01

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.

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® – 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. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:

    a. Damper Identification Tag.
    b. Location.
    c. Damper Type.
    d. Damper Size.
    e. Duct Size.
    f. Arrangement.
    g. Blade Type.
    h. Velocity.
    i. Pressure Drop.
    j. Fail Position.
    k. Actuator Identification Tag.
    l. Actuator Type.
    m. Mounting.

10. 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 C_V.
    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.

11. Airflow Measuring Station Schedule:

a. The manufacturer's authorized representative shall prepare the airflow measuring station submittal, or review and approve in writing the submittal prepared by the TCC prior to submission to the Architect/Engineer and prior to installation. The representative shall review air handling equipment submittals and duct fabrication drawings to ensure that all AFMS locations meet the appropriate parameters to achieve proper installation and the specified accuracy. Comply with all manufacturer's installation requirements including straight up and downstream duct lengths. Install airflow straighteners if required by the manufacturer based on installation constraints. The Architect/Engineer shall be notified for approval of any deviations.

b. Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.

c. Submit installation, operation, and maintenance documentation.

12. 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.

13. Provide PICS files indicating the BACnet® functionality and configuration of each device.

14. 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.

15. 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.

16. Software: A list of operating system software, operator interface software, color graphic software, and third-party software.

17. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.

18. Clearly identify work by others in the submittal.

19. 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 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.

1.7 ACRONYMS

A. Acronyms used in this specification are as follows:

1. B-BC BACnet Building Controller

2. B-AWS BACnet Advanced Workstation

3. B-OWS BACnet Operator Workstation

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

1.8 SUMMARY

A. Provide new standalone FMCS for this project.

B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.

C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.

D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

1.9 LEED REQUIREMENTS

A. This project shall meet the requirements of the U.S. GREEN BUILDING COUNCIL LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED) program.

B. This project will attempt to achieve the U.S. Green Building Council's LEED Version 2.2 certification Level: Certified.

C. This Contractor shall carefully examine the LEED portion of this specification for full compliance with the following LEED points:

1. "Energy & Atmosphere": Prerequisite 1, "Fundamental Building Systems Commissioning," Prerequisite 2 - "Minimum Energy Performance," Credit 3 - "Additional Commissioning," and Credit 5 - "Measurement and Verification," as described by LEED. A complete and total re-commissioning of the TCS may be required at one- and two-year intervals.

2. "Indoor Environmental Quality": Prerequisite 1 - "Minimum IAQ Performance," Credit 1 - "Outdoor Air Delivery Monitoring," and Credit 6.2 - "Thermal Comfort."

3. All labor and materials required for these and any other LEED initiatives shall be provided without additional cost to the Owner.

1.10 SYSTEM DESCRIPTION

A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the B-BC BACnet Ethernet/IP protocol at the HVAC system level and the B-AAC BACnet MS/tp level at the terminal (VAV, FCU) level. Temperature Control System products shall be as specified below.

B. The FMCS shall include B-BC BACnet Building Controllers within each facility. The B-BC controller 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 texting and e-mailing smart 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.

G. The TCC shall use the existing Joliet Junior College Delta Controls Enteliweb graphical user interface for this project and create all necessary graphics, reports and alarms accordingly.

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 B-BC and B-AAC controllers, 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 by Delta Controls Chicago, Inc.. Contact Charlie McLauchlan (630) 589-3800.

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 B-BC BACnet Building Controllers 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 REMOTE NETWORK ACCESS

A. For Local Area Network installations, provide access to the LAN from a remote location via the Internet. The Owner shall provide a connection to the Internet to enable this access via the customer’s intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

2.5 BACNET BUILDING CONTROLLERS (B-BC)

A. The TCC shall supply one or more BACnet Building Controllers (B-BC) as part of this contract. Number of B-BC’s 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 B-BC 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 B-BC. 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 BACnet Building Controller (B-BC) shall provide the following hardware features as a minimum:

1. Three Ethernet Ports – 10/100 Mbps.
2. Two RS-485 ports – 76,800 bps
3. Support BACnet over Ethernet or BACnet IP
4. 32-bit RISC processor, 64 MB flash memory and 32 MB SDRam memory.
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 B-BC must be capable of operation over a temperature range of 32°F to 122°F.
8. The B-BC must be capable of withstanding storage temperatures of between 0°F and 158°F.
9. The B-BC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.

D. The B-BC shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the B-BC shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.

E. Event Alarm Notification and Actions:

1. The B-BC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

2. The B-BC 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.

F. Treat control equipment and network failures as alarms and annunciated.

G. 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. Texting via cellular 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.

H. 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.

I. Give defined users proper access to acknowledge any alarm.

J. A log of all alarms shall be maintained by the B-AWS and/or a server (if configured in the system) and shall be available for review by the user.

K. Provide a “query” feature to allow review of specific alarms by user-defined parameters.

L. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

M. An error log to record invalid property changes or commands shall be provided and available for review by the user.

2.6 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. BACnet Advanced Application Controller (B-AAC):

1. Controls shall be microprocessor based BACnet Advanced Application Controller (B-AAC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide B-AAC 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 BACnet controllers 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-AAC).
   c. BACnet Application Specific Controller(s) (B-ASC).

3. The B-BC shall communicate via an Ethernet connection at a baud rate of not less than 100 BaseT. The B-AAC controllers shall communicate at a baud rate not less than 76,800 bps.

4. Each B-ASC network sensor shall connect directly to the related B-AAC or B-BC controller and shall not use any of the I/O points of the controller. The B-ASC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The B-ASC network sensor shall provide a communications jack for connection to the BACnet communication trunk to which the B-AAC controller is connected. The B-ASC sensor, the B-AAC or B-BC connected controller, and all other devices on the BACnet bus shall be accessible by the POT.

5. All B-AAC or B-BC controller shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require are not acceptable. Store all control sequences within or programmed into the B-AAC or B-BC controller in non-volatile memory that does not depend on a battery to be retained.

6. The Contractor supplying the B-AAC or B-BC controller IBC 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 B-AAC or B-BC controller.

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. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:

b. The language shall be English language oriented, be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or "fill in the blanks").

c. A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and find/replace.

d. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

e. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results. The debugger also shall provide error messages for syntax and execution errors.

f. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

g. The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and x-to-the-y-power. The following mathematical functions also shall be provided: natural log, log, trigonometric functions (sine, cosine, etc.), absolute value, and minimum/maximum value from a list of values.

h. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.

i. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.

j. The programs shall support online changes with the ability to read real time values without exiting the program. Sample programs and syntax help functions shall be resident in the program.

k. 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.

l. Analog Output Object: Minimum requirement is to comply with the BACnet standard for data sharing.

m. 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.

n. 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.

o. 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.

p. 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.

q. 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.

r. 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.

s. Interlock Object: Provide an interlock program 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.

t. Temperature Override Object: Provide a program 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.

u. Object Password Protection: Provide Object Password protection that allows to be password protected to protect the application from tampering.

7. The object library shall include objects to support the integration of devices connected to the BACnet Building B-BC Controller. Provide the following as part of the standard library included with the programming software:

a. 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.

b. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

c. 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.

d. For MODbus devices provide the following support at a minimum:

1) MODbus RTU

2) MODbus IP

2.7 TERMINAL AIR BOX (TAB) CONTROLLERS

A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 23 36 00 for additional information.

B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.

C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.

D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator's terminal connected to the specific controller.

E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.

F. BACnet TAB controllers shall be B-AAC devices as required to meet the JJC campus standard and related BTL listing.

2.8 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

A. The B-BC and B-AAC controllers shall be able to collect data for any property of any object and store resident in the controller 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 controller 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 controllers shall archive its log data remotely to the existing Delta Controls Coppercube historian server on the JJC 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.

2.9 AUDIT LOG

A. Provide and maintain an audit log that tracks all activities performed on the FMCS. 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 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.

2.10 DATABASE BACKUP AND STORAGE

A. The FMCS 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 on the existing JJC Delta Controls Enteliweb and Coppercube network servers. The age of the most recently saved database shall depend on the user-defined database save interval.

2.11 GRAPHIC USER INTERFACE SOFTWARE – EXISTING DELTA CONTROLS ENTELIWEB

A. Operating System:

1. Expand the existing JJC Delta Controls Enteliweb Enterprise level GUI to include all systems specified in this project.

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 per existing campus standard on the Delta Controls Enteliweb GUI.

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 or via text entry – whichever the user prefers.

6. Adjustments to analog objects, such as setpoints, shall be made by selecting the object and using a graphic slider to adjust the value or via text entry – whichever the user prefers.

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.

2.12 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.

2.13 SERVER FUNCTIONS AND HARDWARE

A. Connect the FMCS furnished and installed under this contract scope to the existing Delta Controls Enteliweb GUI as required by the specifications.

B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1.

C. It shall be possible to provide access to all B-BC and B-AAC controllers via a single connection to the server. In this configuration, each B-BC and B-AAC controllers NACs can be accessed from a remote GUI or from a standard WBI by connecting to the server.

D. The server shall provide the following functions:

1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.

2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any B-BC and B-AAC controllers NACs in the network, local or remote.

3. The server shall include a master clock service for its subsystems and provide time synchronization for all B-BC and B-AAC controllers.

4. The server shall accept time synchronization messages from trusted precision atomic clock Internet sites and update its master clock based on this data.

5. The server shall provide scheduling for all B-BC and B-AAC controllers and their underlying field control devices.

6. The server shall provide demand limiting that operates across all B-BC and B-AAC controllers. The server must be capable of running multiple demand programs for sites with multiple meters and/or multiple sources of energy. Each demand program shall be able to support separate demand shed lists.

7. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to B-BC and B-AAC controllers.

8. Each B-BC and B-AAC controllers supported by the server shall be able to automatically archive its log data, alarm data and database to the server. Archiving options shall be user-defined, including archive time and archive frequency.

9. The server shall provide central alarm management for all B-BC and B-AAC controllers supported by the server. Alarm management shall include:

   a. Routing alarms to display, printer, e-mail, and pagers.
   b. Viewing and acknowledging alarms.
   c. Querying alarm logs based on user-defined parameters.

10. The server shall provide central management of log data for all B-BC and B-AAC controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:

    a. Viewing and printing log data.
    b. Exporting log data to other software applications.
    c. Querying log data based on user-defined parameters.

11. Reports shall be generated automatically or manually, and directed to LCD displays, printers, or disk files. The system shall allow the user to easily obtain the following types of reports:

    a. List all points in network.
    b. List all points in alarm.
    c. List all off-line points.
    d. List all points in override status.
    e. List all disabled points.
    f. List all points that are locked out.
    g. List all items defined in a "follow-up" file.
    h. List all weekly and holiday schedules.
    i. List all limits and deadbands.

E. Server Hardware Requirements:

1. No work necessary – the existing Delta Controls Enteliweb GUI resides on a JJC virtual server.

2.14 GRAPHIC USER INTERFACE COMPUTER HARDWARE (TABLET)

A. To facilitate site staff wireless intranet monitoring/adjusting of the control system – TCC must furnish and configure Qty-2 MS Surface tablets with 32 GB memory, detachable

keyboard, touch screen pen, carrying case, 10” screen size, Windows 8 operating system, built-in Wifi and quad core processor or greater/equivalent.

2.15 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.

2.16 DDE DEVICE INTEGRATION

A. The BACnet Building Controller B-BC shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The BACnet Building Controller B-BC 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.

2.17 MODBUS SYSTEM INTEGRATION

A. The BACnet Building Controller B-BC shall support integration of device data from Modbus RTU, ASCII, and TCP control system devices. Connect to the Modbus system via an RS-232, RS485, or Ethernet IP as required by the device.

B. Provide the required objects in the library included with the GUI programming software to support the integration of the Modbus system data into the FMCS. Objects provided shall include, at a minimum:

1. Read/Write Modbus AI Registers.
2. Read/Write Modbus AO Registers.
3. Read/Write Modbus BI Registers.
4. Read/Write Modbus BO Registers.

C. The BACnet Building Controller B-BC shall perform all scheduling, alarming, logging and global supervisory control functions of the Modbus system devices.

D. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment using Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning.

2.18 SOFTWARE

A. The B-BC, B-AAC and B-ASC controllers 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 The B-BC and B-AAC controllers 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 The B-BC and B-AAC controllers programs shall meet the control strategies called for in the sequence of operation of these specifications. Each The B-BC and B-AAC controllers shall have resident in its memory and available to the programs a full library of The B-BC and B-AAC controllers 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 The B-BC and B-AAC controllers setpoints, gains and time constants associated with The B-BC and B-AAC controllers programs shall be available to the operator for display and modification via the operator workstation.

3. The execution interval of each The B-BC and B-AAC controllers loop shall be adjustable from 2 to 120 seconds in one-second increments.

4. The B-BC and B-AAC controllers control programs shall assign initialization values to all outputs so controlled devices assume a failsafe position on start-up.

L. Provide CollegeNet R25 room scheduling software integration to the existing JJC R25 system via the existing Delta Controls Facility Scheduler server. Follow existing campus standards for room (VAVs, FCUs etc) and zone (AHU's, RTUs, Boilers etc) schedule integration with the R25 system.

M. 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.

N. 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 The B-BC and B-AAC controllers 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.

O. The B-BC and B-AAC controllers 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.

P. All electronics shall be:

1. Standard locally stocked modular boards.
2. Plug-in type.

2.19 CONTROL DAMPERS

A. Rectangular Control Dampers - Standard Construction:

1. Shall be licensed to bear the AMCA Certified Rating Seal.

2. Test leakage and pressure drop per AMCA 500.

3. Frame: Hat-shaped channel, minimum 12 gauge extruded aluminum, and minimum 4” deep. Caulk or weld seams to prevent leakage.

4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6” wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable).

5. Shaft: Non-cylindrical, solid aluminum shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.

6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.

7. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.

8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.

9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.

10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.

11. Maximum Leakage: 9 cfm at 1” w.c. pressure differential for a 24”x24” damper.

12. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8,000 cfm through a 24"x24" damper (2000 fpm).

13. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8,000 cfm through a 24"x24" damper (2000 fpm).

2.20 DAMPER ACTUATORS

A. Damper Actuators - Electronic - Spring Return:

1. Damper actuators shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, 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. Following power interruption, spring return mechanism shall close the damper. Mechanical spring shall be rated for a minimum of 60,000 full cycles. Provide breathable membrane in actuator housing to compensate for pressure differential and allow for 95% non-condensing relative humidity in the airstream.

3. Mount actuators with motor outside of airstream whenever possible. Unit casings shall have housing with proper weather, corrosive, or explosion-proof construction as required by application.

4. Actuators shall be rated for 60,000 full cycles at rated torque with 2-year unconditional warranty. Size actuators per damper manufacturer's recommendations.

5. Provide end switches as required for the sequence of operation.

6. Provide analog feedback signal for positive position indication. Refer to FMCS points list.

2.21 HYDRONIC CONTROL VALVES

A. General:

1. Control valves shall be sized for a minimum control valve authority of 0.25.

2. Two-way valves shall be 100% tight-closing. Three-way valves shall be 100% tight-closing in both extreme positions.

3. Modulating two-way valves shall have equal percentage flow characteristics.

4. Modulating three-way valves shall have linear flow characteristics.

5. Piping geometry correction factors for C_v ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.

B. Two-position:

1. Ball 2" and under:

a. Design Pressure: 400 psi

Design Temperature: 212ºF
Design Flow Differential Pressure Rating: 150 psi

b. Bronze or brass body, stainless steel stem, chrome plated brass or stainless steel full port ball, PTFE or RTFE seats and seals, screwed ends (solder ends are acceptable only if rated for soldering in line with 470ºF melting point of 95-5 solder).

2. Ball 3" to 6":

a. Design Pressure: 200 psi

Design Temperature: 212ºF
Design Flow Differential Pressure Rating: 35 psi

b. Cast iron body, stainless steel stem, stainless steel full port ball, PTFE or RTFE seats and seals, flanged ends.

3. Butterfly 2-1/2" to 12":

a. Design Pressure: 125 psi

Design Temperature: -20 to 212ºF
Design Flow Differential Pressure Rating: 50 psi

b. Cast iron body, stainless steel stem with extended neck, aluminum-bronze or nickel-plated iron disc, EPDM seats and seals, fully lugged ends.

C. Modulating:

1. Ball 2" and under:

a. Design Pressure: 400 psi

Design Temperature: 212ºF
Design Flow Differential Pressure Rating: 35 psi

b. Bronze or brass body, stainless steel stem, chrome plated brass or stainless steel full port ball, PTFE or RTFE seats and seals, screwed ends (solder ends are acceptable only if rated for soldering in line with 470ºF melting point of 95-5 solder).

2. Ball 3" to 6":

a. Design Pressure: 200 psi

Design Temperature: 212ºF
Design Flow Differential Pressure Rating: 35 psi

b. Cast iron body, stainless steel stem, stainless steel full port ball, PTFE or RTFE seats and seals, flanged ends.

3. Butterfly 2-1/2" to 12":

a. Design Pressure: 125 psi

Design Temperature: -20 to 212ºF
Design Flow Differential Pressure Rating: 50 psi

b. Cast iron body, stainless steel stem with extended neck, aluminum-bronze or nickel-plated iron disc, EPDM seats and seals, fully lugged ends.

2.22 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.

2.23 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, ± 0.50°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, ± 0.50°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.

3. Water Temperature Sensor:

a. Install in immersion wells. Separate thermometers as specified elsewhere, also of the immersion well type, shall be installed within 2 feet of each temperature sensor.

B. Humidity Measuring Devices:

1. Humidity Sensors:

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

C. Pressure Measuring Devices

1. Differential Pressure Switches:

a. Standard Pressure Switches:

1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.

2) Accuracy shall be ± 3% of full scale maximum throughout entire range at 70ºF.

3) Provide mounting brackets, probes, and shutoff valves required for proper installation.

4) The range and service shall be as required for application or as noted on the drawings.

5) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.

6) Provide latching relays that require manual reset once activated.

7) Acceptable Manufacturer: Dwyer Photohelic Series 3000.

b. High Pressure Switches (Manual Reset):

1) Differential pressure switch with single pole, double-throw snap switch and enclosure.

2) Rated for pressure specified in sequence of control.

3) Electrical rating shall be 15 amps at 120-480 volts.

4) Setpoint adjustment shall be screw type located inside enclosure.

5) Provide optional manual reset for overpressure protection with all tubing, brackets, and adapters.

6) Repeatability: ± 3%.

2. Pressure Transmitters/Transducer:

a. Select device suitable for intended application; water or air, static or differential.

b. Select for appropriate range, including negative if applicable.

c. 100% solid state device, temperature compensated, suitable for pressures of 200% rated range with averaging to stabilize output, accuracy of ± 1% full scale, and a 4-20 mA output.

d. Provide a NEMA 4 enclosure unless panel mounted.

e. Air service shall have a minimum of three field selectable ranges.

f. When used for room pressure control, the transducer shall be bidirectional with a range of ± 0.1" W.C.

g. Provide pressure line outlet cover on both sides of the wall when used for room pressure control.

h. Furnish with integral LED's to indicate Zero Pressure, Pressure In Range, and Pressure Out Of Range as a diagnostic aid.

3. Room Pressure Monitor System:

a. General:

1) The Room Pressure Monitor System shall include a room pressure monitor, remote pressure sensor, door switch, keyed switch, and low voltage control transformer.

2) The system shall continuously measure, display, and monitor the room pressure.

3) All components of the Room Pressure Monitor System shall be completely designed, tested, cataloged, and coordinated for single point responsibility.

4) TCC shall furnish and install all wiring as required to connect system components.

b. Room Pressure Monitor:

1) Shall measure and display room pressure and provide access to menu driven programming options via a keypad. Refer to drawings for room pressure monitor requirements.

2) A minimum of two indicator lights shall be provided on the front of the monitor to indicate ALARM and NORMAL conditions.

3) There shall be an alphanumeric digital display indicating the measured room pressure in inches of H_2O with a display accuracy of 0.001 and shall be updated every second.

4) There shall be low and high pressure audible alarms. Each alarm shall have a unique setpoint.

5) The room pressure monitor shall not be capable of changing the room mode without the use of a password or keyed switch.

6) The room pressure monitor shall accept an input from the door switch to silence the alarm.

7) The room pressure monitor shall accept an input from the FMCS system to change the room mode as indicated in the control sequences.

8) Provide the following inputs/outputs to the FMCS system:

a) Pressure (analog).
b) Room Mode (binary).
c) Alarm (binary).

c. Pressure Sensor:

1) Shall be temperature compensated over a range of 55°F to 95°F.

2) The assembly shall not compromise the fire rating of the wall.

3) Shall measure room pressure from -0.20000 to +0.20000 inches H_2O with an accuracy of ± 0.001 inches H_2O.

4) Shall be bidirectional to determine the proper direction of pressure. Unidirectional sensors are not acceptable.

5) Manufacturer shall provide cable between the pressure sensor and room pressure monitor.

d. Door Switch:

1) Magnetic door switch designed to interface with room pressure monitor.

e. Transformer:

1) The transformer shall have a primary-side voltage of 120 VAC and a secondary-side voltage of 24 VAC.

2) The transformer shall be UL and CSA listed.

3) Manufacturer shall provide cable between the transformer and room pressure monitor.

f. Keyed Switch:

1) Two-position rotating cam-type with key removable in both positions. Rated for 20A at 120V UL listed. Back and side wired. Provide key and stainless steel coverplate in a single gang electrical rough-in box. Provide black laminated three-layer phenolic nameplate with engraved white, 1/4" minimum letters for labels.

2) Provide with spare keys.

D. Flow Measuring Devices:

1. Inline Electromagnetic Flow Meters:

a. General:

1) Each flow meter shall be of the electromagnetic type.

b. Service:

1) Heating Water: Rated for minimum of 240°F service.

c. Electromagnetic Flow Tube:

1) Each meter shall be rated for system pressure and shall have adequate structural integrity for a flow rate equal to 150% of the scheduled maximum initial or future flow rate, whichever is greater.

2) Each meter shall have flanged connections to match piping pressure class, an outer body constructed of painted carbon steel, a full line-size 304 stainless steel flow tube, 316 stainless steel electrodes, and a liner that is fully compatible with the chemical content of the flow media.

3) Each meter shall be provided with an adequate means for grounding the process fluid (e.g., grounding rings or a grounding electrode).

d. Transmitter:

1) Each meter shall incorporate a remote mounted programmable transmitter that incorporates a digital display. For remote mounted transmitters, 25 foot minimum cable length shall be provided with each unit unless otherwise scheduled or noted within the documents. The cable length shall be adequate to satisfy specific installation requirements.

2) Each transmitter shall calculate and display flow rate and net totalized flow, along with associated engineering units (e.g., GPM and Gal.).

3) Each transmitter shall produce an analog output signal that is directly proportional to volumetric flow rate. This signal shall be scalable to indicate flow rate in either direction. In lieu of such bidirectional scalability, two separate pulsed outputs shall be provided. One shall indicate incremental flow in one direction, while the other indicates incremental flow in the opposite direction such that net totalized flow can be calculated remotely.

4) Unless scheduled or otherwise indicated, the initial span adjustment of each transmitter shall be 0-120% of the scheduled maximum flow rate.

5) Each transmitter shall incorporate self-diagnostics and test functions in order to permit internal checks of all outputs and displays, and to verify the accuracy of the unit and the integrity of the current loop without any external equipment.

e. Accuracy:

1) Non-billing Purposes: The accuracy of each meter/transmitter assembly shall be ± 0.5% of flow rate reading over a range of 3-15

feet/second fluid velocity, with a repeatability of 0.1%. Accuracy at 1 foot/second shall be ± 0.75%.

f. Display Unit:

1) Pair with Display Unit described below.

g. Calibration:

1) Each meter shall be calibrated on an NIST traceable flow stand at 1, 8, and 15 feet/second. Provide written documentation of calibration.

h. Installation and Startup:

1) Each meter assembly shall include detailed installation and operation instructions, including piping straight run requirements.

2) Provide on-site startup, commissioning, and training.

i. Warranty:

1) Each meter assembly shall carry a performance warranty of at least two years from the date of installation and startup. This warranty shall cover parts and labor for repair or replacement of the meter assembly. Performance during the warranty period shall satisfy the above-stated requirements for accuracy and repeatability.

j. Approved Manufacturers:

1) ABB, Yokogawa, Rosemount, Onicon, Badger.

2. Display Unit:

a. General:

1) The display shall compatible with virtually any flow meter.

2) The display module shall provide a local indication of liquid flow rate and net totalized flow, along with associated engineering units (e.g., GPM/second and gallons).

3) It shall have a network interface to communicate flow data to the building control network.

4) House in a steel wall-mounted enclosure with a built-in user interface/display.

5) Display unit shall accept 4-20 mA pulse or contact closure flow signals. It shall also function as a network interface for two (2) additional analog rate inputs and one (1) additional totalizing pulse input. LonWorks communication protocols.

6) The display shall have two-line alphanumeric LCD displays of flow rate and flow total.

7) The display shall have non-volatile EEPROM memory that retains all program parameters and totalized values in the event of power loss.

8) Electrical Power Supply: 24VAC. 60Hz, 500mA max.

b. Approved Manufacturers:

1) Onicon, Yokogawa.

3. Airflow Measuring Stations:

a. In accordance with the requirements of LEED EQc1: Outdoor Air Delivery Monitoring, any AFMS used to measure outside air CFM shall have an accuracy of ±15% of the design minimum outdoor air flow rate (or better). The AFMS accuracy shall also comply with requirements outlined in the following paragraphs of this specification.

b. Duct Mounted Airflow Measuring Stations (AFMS) - Thermal Dispersion

1) Provide airflow/temperature measurement devices where indicated on the plans.

2) Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

a) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.

b) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.

c) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.

d) Devices using less than two thermistors in each sensor assembly are not acceptable.

e) Devices using platinum wire RTDs are not acceptable.

f) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.

g) Pitot tubes and arrays are not acceptable.

h) Vortex shedding devices are not acceptable.

3) All Sensor Probes

a) Each sensor assembly shall independently determine the velocity and temperature at its measurement point.

b) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).

c) Airflow measuring station assembly accuracy shall be +/- 2% of Reading over the entire operating airflow range. Temperature accuracy shall be +/-0.15° F between -20° F and 160° F.

d) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).

e) Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

f) The number of probes shall be as recommended by the manufacturer to achieve the specified accuracy.

4) Duct and Plenum Probes

a) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.

b) Probe assembly mounting brackets shall be constructed of 304 stainless steel.

c) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5) Sensor Density

Area (sq.ft.)	Total # of Sensors Required
< 2	4
2 to < 4	6
4 to < 8	8
8 to < 16	12
≥ 16	16

6) Transmitters

a) The transmitter shall have an integral 16 character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.

b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.

c) The operating temperature range for the transmitter shall be -20° F to 120° F.

d) The transmitter shall be capable of communicating with other devices using one of the following interface options:

(1) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)

(2) RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

(3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.

(4) LonWorks Free Topology

E. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:

a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

2. Current Switches for Motors Controlled by VFD:

a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with N.O. output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

F. Occupancy Sensors:

1. Use auxiliary contacts on sensor provided and installed by the Electrical Contractor. Refer to electrical drawings for sensor location and specifications. Coordinate with Electrical Contractor.

G. Carbon Monoxide Sensors:

1. Solid-state gas sensor/transmitter, NEMA 1 NEMA 4X gasketed enclosure, normal operating temperature 0-120°F, normal relative humidity operation 5-95%, ± 5% accuracy, and detection range of 0-200 ppm.

2. Provide 4-20 mA output from the sensor to the FMCS system.

3. Provide local alarm whenever carbon monoxide level exceeds 100 ppm.

4. Install in accordance with OSHA requirements.

5. Unit shall be factory calibrated and shall be re-calibrated after installation per manufacturer's recommendations.

H. Carbon Dioxide Sensors:

1. Microprocessor based non-dispersive infrared sensor with range of 0 to 2,000 ppm CO2 with ± 100 ppm accuracy, maximum drift (compensated) of ± 5% full scale in five years, VOC software and hardware sensing, duct mounting where applicable, 0-10V dc or 4-20 mA output directly proportional to ppm, adjustable alarm limit, membrane filter, and terminal block. The diffusion gas chamber in the sensor shall incorporate a reflective light pipe or wave guide surrounded by a gas permeable membrane that prevents particulate contamination of the sensor. Unit shall have selectable IAQ mode with output signal and sum of CO2 and VOC levels.

I. Miscellaneous Devices:

1. Control Relays:

a. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.

b. Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.

c. Tork A500 Series, Intermatic FD Series, or Marktime Series 93.

2.24 CONDUIT

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

2.25 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, temperature and humidity sensors, and other exposed sensors) 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". In accordance with the requirements of LEED EQc1: Outdoor Air Delivery Monitoring, install all wall-mounted CO2 sensors between 3 feet and 6 feet above the floor.

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 rooftop 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. 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.

N. VFD's:

1. This project includes several variable frequency drives to control the flow of fans and/or pumps based on a control variable.

2. Verify output signal required, 4-20 mA or 0-10V dc, with the EC.

3. If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.

4. If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.

5. Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

O. Airflow Stations:

1. The transmitter shall be installed at a location that is protected from weather, water, and vibration.

2. Mount transmitter where they can easily be read (36" to 66" above floor). Do not fasten transmitters directly to ductwork or compromise duct insulation.

3. The manufacturer's authorized representative shall visit the project site during construction prior to station installations to confirm all submitted sizes, mounting requirements and locations. Size adjustments shall be made at no additional cost. The representative shall meet on site with the TCC to support and train them on proper installation procedures and calibration.

4. Install labels at each sensor and transmitter identifying its service.

3.2 GRAPHIC DISPLAY

A. Create a customized graphic for each piece of equipment indicated on the itemized points list per existing JJC Delta Controls Enteliweb system standard.

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. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone's TAB graphic.

5. Show the location of each thermostat on the floor plan.

6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures 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.

7. 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.

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 de-bugging 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 broken up into two separate days for 4 Owner's representatives. The owner shall designate training dates to fit staff schedules. 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.

B. Day-to-Day Operations - Training Description:

1. Proficiently operate the system.
2. Understand control system architecture and configuration.
3. Understand FMCS systems components.

4. Understand system operation, including FMCS system control and optimizing routines (algorithms).
5. Operate the workstation and peripherals.
6. Log-on and off the system.
7. Access graphics, point reports, and logs.
8. Adjust and change system setpoints, time schedules, and holiday schedules.
9. Recognize malfunctions of the system by observation of the printed copy and graphic visual signals.
10. Understand system drawings and Operation and Maintenance manual.
11. Understand the job layout and location of control components.
12. Access data from FMCS controllers and ASC's.
13. Operate portable operator's terminals.

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.

G. Install all wall-mounted CO2 sensors between 3 feet and 6 feet above the floor.

3.12 INSTALLATION OF FLOW METERS

A. Provide manufacturer's recommended lengths of straight piping upstream and downstream of the flow meter. Up to 30 diameters upstream of the flow meter may be required depending on the piping arrangement and flow meter type.

B. Maintain adequate pull/service space.

END OF SECTION 23 09 00

SECTION 23 09 13 - INSTRUMENTATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure Gauge.
B. Pressure Gauge Accessories.
C. Thermometers.
D. Test Plugs.
E. Static and Differential Airflow Pressure Gauges.

1.2 REFERENCES

A. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.

B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.

C. ASTM E1 - Specification for ASTM Thermometers.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for air, steam, water or oil application, 1/4" or 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.

B. Acceptable Manufacturers: Ashcroft, Marsh, Marshalltown, Miljoco, Trerice, U.S. Gauge Figure 1901, Weiss, Weksler, Wika.

C. Select gauge range for normal reading near center of gauge.

2.2 PRESSURE GAUGE ACCESSORIES

A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.

B. Shutoff Valve: 1/4" ball valve as specified for each piping system.

C. Pressure snubber, brass with 1/4" connections, porous metal type.

2.3 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”.

4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Wells shall extend through insulation. Thermometers for air shall have an aluminum or brass duct flange.

5. Acceptable Manufacturer: Marsh, Miljoco, Trerice, Weiss, Weksler, Wika.

B. Select scales to cover expected range of temperatures.

2.4 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.

2.5 STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES

A. Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.

B. Accuracy shall be ± 3% of full scale maximum throughout entire range at 70°F.

C. Provide mounting brackets, probes, and shutoff valves required for proper installation.

D. The range and service shall be as required for application or as noted on the drawings.

E. Acceptable Manufacturers: Dwyer Magnehelic Series 2000, Marshalltown Instrument Series 85C.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install per manufacturer's instructions.

2. Coil and conceal excess capillary on remote element instruments.

3. Install gauges and thermometers in locations where they are easily read from normal operating level.

4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Pressure Gauges:

1. Connect pressure gauges to suction and discharge side of all pumps.

2. Provide snubber for each pressure gauge.

3. Provide coil syphon for each pressure gauge connected to steam piping.

C. 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.

3. Locate duct thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

END OF SECTION 23 09 13

SECTION 23 11 23 - NATURAL GAS AND PROPANE 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 AGA-LC1 - Standards for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing.

C. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

D. ASME - Boiler and Pressure Vessel Code - Section 9.

E. ASME B1.20.1 - Pipe Threads, General Purpose.

F. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.

G. ASME B16.5 - Pipe Flanges and Flanged Fittings.

H. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.

I. ASME B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.

J. ASME B16.21 - Nonmetallic Flat Gaskets for Pipes Flanges.

K. ASME B16.39 - Malleable Iron Threaded Pipe Unions.

L. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.

M. ASME B18.2.2 - Square and Hex Nuts, Inch Series.

N. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

O. ASTM A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.

P. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.

Q. ASTM A197 - Standard Specification for Cupola Malleable Iron.

R. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

S. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

T. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

U. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.

V. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe.

W. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

X. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

Y. 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: 350ºF

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. For Underground Gas Piping - Refer to paragraph “Underground Piping Protection."

E. 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-1: 2" and under, 125# steam @ 450ºF, 175# CWP @ 180ºF, cast iron body, screwed, full port. Walworth #1700, DeZurik #425, S-RS49.

3. PL-2: 2-1/2" thru 4", 125# steam @ 450ºF, 175# CWP @ 180ºF, flanged, cast iron body, full port. Walworth #1700F, DeZurik #425, F-RS49.

2.2 DRAIN VALVES AND BLOWDOWN VALVES

A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4” male hose thread outlet, cap, and retaining chain.

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. Install thrust blocking and restraints on all buried piping at elbows and other changes in pipe direction.

G. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.

H. Provide valve position indicator on all valves 10’-0” or greater above finish floor and not located above ceiling.

I. Provide clearance for access to valves and fittings.

J. Provide access doors where valves are not exposed.

K. Prepare pipe, fittings, supports, and accessories for finish painting.

L. Install valves with stems upright or horizontal, not inverted.

M. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

N. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

O. 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.

P. Lay all underground piping in trenches. Provide and operate pumping equipment to keep trenches free of water.

Q. Provide flanges or unions at all final connections to equipment, traps and valves.

R. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

S. 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.

T. Underground Piping Protection:

1. Direct buried, uninsulated steel pipe shall have a factory applied external protective coating consisting of two coats with an intermediate layer of 18 mil fibrous glass mat. Coating thickness shall total not less than 3/32". The outer coating shall be further protected by a wrapping of heavy kraft paper. This external protection shall extend and be exposed for a minimum of 1 foot beyond the buried or concealed portion of the pipe.

    a. Acceptable Manufacturers: Pipe Line Service Co., Franklin Park, Illinois, Lithcote Corp., Melrose Park, Illinois

2. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.

    a. Acceptable Manufacturer: Republic Steel Corp. "X-Tru-Coat"

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.

U. Each above ground portion of a gas piping system, other than corrugated stainless steel tubing systems, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than corrugated stainless steel tubing, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.

V. Gas piping shall not be used as a grounding conductor or electrode.

W. 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.

I. 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.

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 500ºF 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 400ºF. Backing rings shall be of the material being welded.

END OF SECTION 23 11 23

SECTION 23 21 00 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings.
B. Valves.
C. Heating Water 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.

1.3 REFERENCES

A. ANSI/ASTM D2466 - PVC Plastic Pipe Fittings, Schedule 40.

B. ANSI/AWS D1.1 - Structural Welding Code.

C. ANSI/AWWA C104/A21.4 - Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.

D. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3" through 48", for Water and Other Liquids.

E. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

F. ANSI/AWWA C150/A21.50 - Thickness Design of Ductile Iron Pipe.

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/A21.51 - Ductile Iron Pipe, Centrifugally Cast for Water or Other Liquids.

I. ASME - Boiler and Pressure Vessel Code.

J. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

K. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.

L. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

M. ASME B16.5 - Pipe Flanges and Flanged Fittings.

N. ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.

O. ASME B16.12 - Cast Iron Threaded Drainage Fittings.

P. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings

Q. ASME B16.21 - Nonmetallic Flat Gaskets for Pipes Flanges.

R. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

S. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).

T. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

U. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.

V. ASME B18.2.2 - Square and Hex Nuts, Inch Series.

W. ASME B31.3 - Chemical Plant and Petroleum Refinery Piping.

X. ASME B31.9 - Building Services Piping.

Y. ASME Section 9 - Welding and Brazing Qualifications.

Z. ASTM A126 - Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings.

AA. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

BB. ASTM A181 - Forgings, Carbon Steel for General Purpose Piping.

CC. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

DD. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

EE. ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.

FF. ASTM B32 - Standard Specification for Solder Metal.

GG. ASTM B88 - Seamless Copper Water Tube.

HH. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.

II. ASTM D1599 - Standard Test Method for Short-Time Hydraulic Failure Pressure of Plastic Tubing and Fittings.

JJ. ASTM D1785 - Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.

KK. ASTM D2105 - Standard Test Method for Longitudinal Tensile Properties of Fiberglass Pipe and tube.

LL. ASTM D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate loading.

MM. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

NN. ASTM D2992 – Standard Practice for Obtaining Hydrostatic Design Basis for Fiberglass pipe and fittings.

OO. ASTM D2996 - Standard Specification for Filament Wound Fiberglass Pipe.

PP. ASTM D4024 - Standard Reinforced Thermosetting Resin Flanges.

QQ. ASTM D5685 - Standard for Fiberglass Pressure Pipe Fittings.

RR. ASTM E90-02 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

SS. ASTM E413-87 - Classification for Rating Sound Insulation

TT. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.

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 required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.1 HEATING WATER

A. Design Pressure: 125 psig.
Maximum Design Temperature: 225ºF. (230ºF for mechanical couplings)

B. Piping - 2” and Under (Contractor’s Option):

1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.

2. Joints: Mechanical press connection.

3. Fittings: Copper, ANSI B-16.22, with embedded EPDM o-ring, NSF-61.

4. Acceptable Manufacturers: Viega, NIBCO Press.

C. Piping All Size (Contractor’s Option):

1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.

2. Joints: Mechanical press connection.

3. Fittings: Copper, ANSI B-16.22, with embedded EPDM o-ring, NSF-61.

4. Acceptable Manufacturers: Viega, NIBCO Pressystem.

D. Piping - 2-1/2" and Over:

1. Pipe: Standard weight black steel, beveled ends, ASTM A53, Type E or S, Grade B.

2. Joints: Butt-welded or flanged.

3. Fittings: Standard weight wrought steel, butt-welding type, ASTM A234, ASME B16.9.

4. Flanges: Class 150 forged steel, welding neck or slip-on, ASTM A181 or A105, Class 60, ASME B16.5 up to 24" and B16.47 above 24". ASME B16.1 for flanges mating with flat face equipment flanges.

E. Piping - 2-1/2" and Over (Where Exposed in the Mechanical Room Only):

1. Pipe: Standard weight black steel, grooved ends, ASTM A53, Type E or S, Grade B.

2. Joints: Grooved type, with Grade E EPDM molded pressure-responsive gaskets suited for 32°F to 230°F per ASTM D2000.

3. Fittings: ASTM A536 Grade 65-45-12 ductile or A47 malleable iron, grooved type.

4. Flanges: Grooved end, flanged adapter.

F. Shutoff Valves:

1. Ball Valves:

a. BA-1: 3" and under, 150 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 stem, 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 with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.

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

b. BA-1A: 2-1/2" and 3", 150 psi saturated steam, 275 psi WOG 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.

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

2. Butterfly Valves:

a. BF-1:

1) 2-1/2" thru 6", 175 psi WOG, elastomers rated for 20°F to 250°F at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, Nibco N200 Series, Milwaukee CL series, Hammond 5200 series.

2) Mechanically coupled grooved end valves are acceptable if they have the features listed above. Victaulic #608, Nibco GD4765.

G. Throttling Valves:

1. Globe Valves:

a. GL-1: 2" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #95, Milwaukee #590, Hammond #IB413T, Watts #B-4010-T, NIBCO #T-235.

b. GL-5: 2" and under, 300 psi WOG, solder, bronze. Hammond #IB423, Stockham #B24T, Milwaukee #1590, Watts #B-4011-T, NIBCO #S-235.

2. Butterfly Valves:

a. BF-4:

1) 2-1/2" thru 6", 175 psi WOG, elastomers rated for 20ºF to 250ºF at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size. Victaulic #300,

Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, NIBCO #LD2000, Milwaukee CL series, Hammond 5200 series.

H. Check Valves:

1. CK-1: 2" and under, 125 psi S @ 353ºF, 200 psi WOG @ 150ºF, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319, Walworth #406, Milwaukee #509, Watts #B-5000, or NIBCO #T-413.

2. CK-4: 2" and under, 200 psi WOG @ 150ºF, solder, bronze, horizontal swing. Crane #1342, Hammond #IB912, Stockham #B309, Walworth #406SJ, Milwaukee #1509, Watts #B-5001, or NIBCO #S-413.

3. CK-13: 2-1/2" thru 12", 200# WOG, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size. Mueller Steam Specialty Co. #71-AHB-6-H, Stockham #WG-961, NIBCO W-920-W, Crane, Victaulic #716.

I. Strainers:

1. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi WOG @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777, NIBCO T-122.

2. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi WOG @ 150°F. Armstrong #A1FL, Metraflex #TF, Mueller Steam Specialty Co.#758, Sarco #CI-125, Watts #77F-D, Victaulic #732, NIBCO F-721-A.

2.2 UNDERGROUND PIPING - INSIDE BUILDING
HEATING WATER

A. Design Pressure: 175 psig.
Maximum Design Temperature: 200ºF.

B. Piping:

1. Tubing: Type K annealed temper seamless copper tube, ASTM B68.

2. Joints: Brass compression or flared type.

3. Fittings: Brass compression or flared type, ANSI/ASME B16.26.

C. Joints are permitted only if the maximum available coil length is exceeded. Fittings are permitted only if tees are shown on the drawings.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tubing: DWV drawn temper seamless copper drainage tube, ASTM B306.

1. Fittings: ASME B16.23 cast brass, or ASME B16.29 solder wrought copper.

2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.

B. Piping 4” and Under (Contractor’s Option):

1. Tubing: DWV drawn temper seamless copper drainage tube, ASTM B306

2. Joints: Mechanical press connection.

3. Fittings: Copper, ANSI B-16.22, with embedded EPDM o-ring, NSF-61.

4. Acceptable Manufacturers: Viega.

C. Piping Under 1-1/4" Size:

1. In sizes where drainage type fittings are not available, tees with threaded caps to permit rodding are acceptable.

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.

2.4 AIR VENTS

A. 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.

B. On branch lines and small heating units - Use coin-operated air vent equal to B&G #4V, attached to 1/8" coupling in top of pipe. Install air vents on all coils and terminal heating units.

2.5 AUTOMATIC AIR VENTS

A. High/low capacity automatic air vent (for air separator connection). Maximum operating pressure and temperature of at least 240°F and 125 psi, 3/4" inlet, 3/8" minimum outlet. B&G #107, Armstrong, Spirotherm, Taco, or Watts.

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"	2-1/2" - 8"
Air and Gases	1/32"	3/64"
Water and Glycol/Water	1/32"	1/16"

B. Furnish pipe nipple with ball valve, threaded hose connection, and cap to blow down all strainer screens.

C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.7 MAKE-UP WATER ACCESSORIES

A. Pressure Reducing Valve:

1. For water fill lines to hydronic systems.

2. Pressure reducing valve. Removable strainer, field adjustable discharge pressure, brass body, disc and seat, union with 1/2" or 3/4" NPT sweat connection, 125 psig maximum working pressure, 225°F maximum temperature.

3. Acceptable Manufacturers: Armstrong, Bell & Gossett, Conbraco, Thrush, Watts.

B. Relief Valve:

1. For water fill lines to hydronic systems.

2. Cast iron or bronze body, 1/2" or 3/4" screwed connections, 125 psig working pressure, 225°F maximum temperature. Minimum 500,000 Btuh capacity at 30 psig. Manual test lever.

3. Acceptable Manufacturers: Armstrong, Bell & Gossett, Conbraco, Taco, Watts.

C. Backflow Preventer:

1. Reduced pressure type as scheduled on the drawings.

2. Provide an air gap fitting and piping to drain.

3. If not indicated on the drawings, unit shall be same size as pipe.

4. Field test and tag units per manufacturer's instructions by a certified tester before initial operation.

2.8 SAFETY RELIEF VALVES

A. SRV-1 (Hydronic Heating Systems): Spring-loaded disc type with cast iron or bronze body, bronze or stainless steel disc, side outlet and lifting lever for maximum service of 125 psig at 250ºF. For relieving water during pressure fluctuations and in case of control failure. Capacities shall be ASME Section IV certified and labeled. Acceptable Manufacturers: Kunkle # 537, B&G, Conbraco, McDonnell & Miller, or Watts.

2.9 BALANCING VALVE

A. Rated for 125 psi working pressure and 250ºF 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. Furnish one meter kit.

D. Valves in copper piping shall be brass or bronze. Acceptable Manufacturers: Flow Design “Accusetter”, Presso “B+”, Armstrong "CVB", Bell & Gossett "Circuit Setter Plus",

Griswold “Quickset”, Gerand “BALVALVE Venturi”, NIBCO 1710 (S1710L), Tour&Anderson (STAD), Nexus Valve “UltraXB Orturi”, Victaulic 785.

E. Balancing valves in ferrous piping over 2" size shall have flanged or grooved ends and steel or cast iron construction. Acceptable Manufacturers: Flow Design “Accusetter”, Presso “B+”, Taco “Accu-flo”, Armstrong "CVB-II", B&G “Circuit Setter”, NIBCO 737, Nexus Valve “Nextrol NXFB”, Tour&Anderson (STAF, STAG), Victaulic 788/789, or flow sensor specified in Section 23 09 00 with a specified throttling valve.

F. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

2.10 EXPANSION TANK

A. Bladder Type:

1. Tank shall be welded steel, ASME construction and stamped.

2. Tank shall be complete with heavy-duty replaceable butyl bladder, charging valve, lifting ring, drain tapping, and system connection.

3. 125 psig working pressure and 240ºF maximum operating temperature.

4. Acceptable Manufacturers: Thrush, Taco, Bell & Gossett, Armstrong, Watts, Wessels, Wheatley, Amtrol, Patterson.

2.11 AIR SEPARATORS

A. Separators shall be ASME constructed and stamped for 125 psi working pressure and 350ºF operating temperature.

B. Provide openings for inlet, outlet, blowdown, and expansion tank.

C. Separators shall be line size or larger, with maximum pressure drop of 1 psi. Refer to drawing for separator sizing.

D. Separators shall not include strainers, unless noted on the drawings. When furnished, strainers shall be removable and the blowdown fittings shall have drain valves.

E. Acceptable Manufacturers: Amtrol, Armstrong, Bell & Gossett, Taco, Wheatley, Patterson.

2.12 DRAIN VALVES AND BLOWDOWN VALVES

A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

2.13 CONNECTIONS BETWEEN DISSIMILAR METALS

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron, steel, and stainless steel connected to each other.

2. Brass, copper, and bronze connected to each other.

3. Brass or bronze valves and specialties connected to steel, iron, or stainless steel in closed systems. Where two brass or bronze items occur together, they shall be connected with brass nipples.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.

2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.

F. Flanged Joints (any size):

1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.

2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.

3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.

4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.

5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.

6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

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. Heating Water:

1. Test pipes underground or in chases and walls before piping is concealed.

2. Complete testing before insulation is applied. If insulation is applied before pipe is tested and a leak ruins the insulation, replace all damaged insulation.

3. Test the pipe with 100 psig water pressure. Hold pressure for at least two hours.

4. 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, 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.

B. Chemical Cleaning:

1. Flush pipe and components with clean water until all discharge from system is clean. Maintain minimum velocities at all points of 5 feet/second for 30 minutes. 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, all residual water shall be drained and/or blown out.

2. Add 2 pounds of trisodium phosphate per 100 gallons of system capacity. Use an alternate chemical if discharge of trisodium phosphate is not permitted. Maintain 150°F in the system if possible. If heat is not available, use 3 pounds per 100 gallons.

3. Drain the system after circulating the chemical cleaner for six hours at 150°F, or 12 hours at a lower temperature. Refill. Test a water sample. Drain and fill again if excessive cleaning chemicals remain and until water appears clear.

4. After circulating the chemical cleaner for six hours at 150ºF, or 12 hours at less than 90ºF, connect fresh water to the system and discharge to a drain. Run circulating pumps and flush until discharge is clear water.

5. When system water is clear, remove, clean and replace all strainers.

6. Add chemical treatment as specified in Section 23 25 00.

7. Water samples may be taken by the Architect/Engineer to verify a clean system. If system is not clean, the entire process, including chemical treatment specified in Section 23 25 00, shall be repeated at the Contractor's expense.

8. Chemical cleaning applies to the following systems:

    a. Heating Water

3.4 INSTALLATION

A. General Installation Requirements:

1. 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.

2. Install piping to conserve building space, and not interfere with other work.

3. Group piping whenever practical at common elevations.

4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

5. 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.

6. Install bell and spigot pipe with bells upstream.

7. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

8. Branch takeoffs shall be from the top, side, or bottom of piping.

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 plus its required clearance space.

C. Valves/Fittings and Accessories:

1. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.

2. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.

3. Provide clearance for installation of insulation, and access to valves and fittings.

4. Provide access doors where valves are not exposed.

5. Install balancing valves with the manufacturer's recommended straight upstream and downstream diameters of pipe.

6. Prepare pipe, fittings, supports, and accessories for finish painting.

7. Install valves with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.

8. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

9. Provide flanges or unions at all final connections to equipment, traps and valves.

10. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

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 6" bedding layer of sand below the all pipe. 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 Proctor density. Backfill with sand up to 6" above pipe. Remaining backfill may be soil, unless under paving or buildings, in which case it shall be sand and compacted to 90 percent Proctor density.

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. 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 being made only at control valve or pump.

H. 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.

I. 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, removal of condensate, and venting.

B. Provide drain valves at all low points of water piping systems or where indicated on drawings for complete or sectionalized draining. Drain valves are defined above.

C. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install all liquid lines with top of pipe and eccentric reducers in a continuous line.

D. Provide air vents at all high points and wherever else required for elimination of air in all water piping systems. Do not use automatic air vents in glycol systems unless they are piped to the fill tank.

E. Air vents shall be in accessible locations. If needed to trap and vent air in a remote location, a 1/8" pipe shall connect the tapping location to a venting device in an accessible location.

F. All vent and drain piping shall be of same materials and construction as the service involved.

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.

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. Bronze flanges shall conform to B16.24 and ductile iron flanges to B16.42. Steel flanges shall be raised face except when bolted to flat face cast iron flange.

2. Bolting shall be ASTM A307 Grade B with bolts and heavy hexagonal nuts conforming to ASME B18.2.1 and B18.2.2.

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 ASME B16.5. All gaskets shall conform to ASME B16.21. 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 and glycol solution systems operating 140°F and less.

e. Maximum temperature rating of at least 250°F for water and glycol solution systems operating above 140°F and up to 180°F.

C. Solder Joints:

1. Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 Grade 95TA. Cut copper tubing ends 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, to all surfaces to be joined. Heat joints uniformly to proper soldering temperature so solder flows to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.

2. Flux shall be non-acid type conforming to ASTM B813.

3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470ºF melting point solder. Remove composition discs and all seals during soldering if not suitable for 470ºF.

D. 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" pipe size and over and for all sizes where operating pressure is over 200 psig and/or temperature is over 400ºF. Backing rings shall be of the material being welded.

E. Grooved Joints:

1. Grooved connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall have malleable iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure increases the tightness of the seal.

2. All work, including pipe grooving, shall be accomplished in accordance with manufacturer's published instructions.

3. Final tightening of bolts shall be with a torque wrench to ensure equal tension in all bolts.

4. All fittings shall be provided by one manufacturer. Mixing fittings will not be acceptable.

5. Acceptable Manufacturers: Victaulic, Gruvlok, or Star Fittings.

F. Mechanical Press Connection:

1. Copper press fitting shall be made in accordance with the manufacturer’s installation instructions.

2. Fully insert tubing into the fitting and mark tubing.

3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.

4. Joint shall be pressed with a tool approved by the manufacturer.

END OF SECTION 23 21 00

SECTION 23 21 23 - HVAC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. All pumps except where integral with a manufactured piece of equipment.
B. Pump controls where self-contained.

1.2 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 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.

D. Submit motor data indicating compliance with Section 23 05 13.

PART 2 - PRODUCTS

2.1 PUMPS - 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. Heating pumps shall be suitable for 225ºF water.

F. Motors shall comply with Section 23 05 13.

G. Pump impellers shall not have smaller diameters than those scheduled. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.

2.2 IN-LINE PUMP

A. Type: Centrifugal, single stage, close coupled in-line, back pullout design, suitable for horizontal or vertical operation.

B. Casing: Cast iron, rated for greater of 125 psior 1.5 times actual working discharge pressure, flanged suction and discharge with gauge ports.

C. Impeller: Bronze or stainless steel, fully enclosed, dynamically balanced, keyed to shaft and secured with locknut.

D. Shaft: Steel or stainless steel.

E. Seals: Carbon rotating against a stationary ceramic seat.

F. Acceptable Manufacturers: Bell & Gossett, Taco, Aurora, Armstrong, Grundfos/Peerless/PACO, Patterson, Weinman/Crane.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install all products per manufacturer's recommendations.

2. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger pump suction and discharge pipes. Allow a minimum of 18” clearance for removal of suction diffuser.

3. 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.

4. For pumps not powered by a VFD, trim impeller to meet maximum operating conditions. Coordinate final trimmed diameter with Testing, Adjusting, and Balancing Contractor and Architect/Engineer.

5. Install on vibration isolators as scheduled on drawings.

B. In-Line Pumps:

1. Support in-line pumps individually so there is no strain on the piping. Install with a minimum of five diameters of straight pipe on pump suction and discharge.

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERATION PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping and Pipe Fittings

1.2 QUALITY ASSURANCE

A. Remanufactured specialties are not acceptable.

1.3 REFERENCES

A. ANSI/ASME SEC 8D - Boilers and Pressure Vessels Code, Rules for Construction of Pressure Vessels.

B. ANSI/ASME SEC 9 - Boilers and Pressure Vessels Code, Welding and Brazing Qualifications.

C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. ANSI/ASME B31.5 - Refrigeration Piping.

E. ANSI/ASTM B32 - Solder Metal.

F. ANSI/ASTM B88 - Seamless Copper Water Tube.

G. ANSI/AWS A5.8 - Brazing Filler Metal.

H. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labels in place.

B. Protect piping and specialties from entry of foreign material by leaving caps and plugs in place until installation.

PART 2 - PRODUCTS

2.1 PIPING

A. Design Pressure: 450 psig.

1. Maximum Design Temperature: 250ºF.

B. Piping - 4" and under.

1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.

2. Joints: Brazed with silver solder.

3. Fittings: Wrought copper solder joint, ANSI B16.22.

4. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

3.2 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

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. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. 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.

F. Group piping whenever practical at common elevations and locations. Slope piping 1% in direction of oil return.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access doors for concealed valves and specialties.

J. Where pipe support members are welded to structural building frame, brush clean, and apply zinc rich primer to welding.

K. Insulate piping; per Section 23 07 19.

L. Fully charge system with refrigerant after testing.

3.3 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 their conformance with specified requirements.

C. Exercise care at all times 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 or system. 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.

F. Cut all pipe to exact measurement and install without springing or forcing.

3.4 FIELD QUALITY CONTROL

A. Test piping system with nitrogen at 300 psig for at least 8 hours without loss of pressure.

B. During the 8 hour period under the test pressure, strike all soldered joints sharply with a rubber or rawhide mallet to cause failure of all weak joints.

C. After pressure testing, evacuate all refrigerant piping to at least 28" of mercury for 24 hours without loss of vacuum. Evacuate at an ambient temperature of 70ºF or higher.

END OF SECTION 23 23 00

SECTION 23 25 00 - CHEMICAL (WATER) TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Treatment for Closed Systems (Water).
B. Chemical Feed Equipment.

1.2 REFERENCES

A. ASTM D 859-00: Test Method for Silica in Water

B. ASTM D 1066-97: Practice for Sampling Steam

C. ASTM D 1067-92: Test Methods for Acidity or Alkalinity in Water

D. ASTM D 1068-03: Test Methods for Iron in Water

E. ASTM D 1126-02: Test Method for Hardness in Water

F. ASTM D 1129-03a: Terminology Relating to Water

G. ASTM D 3370-95a: Practices for Sampling Water from Closed Conduits

H. AWWA C700-02: Cold-Water Meters – Displacement Type

1.3 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include data on pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs.

C. Include step-by-step instructions on test procedures including target concentrations and test frequencies.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for delivery to public sewage systems.

B. Provide only chemicals approved for use and disposal by local authorities. Contact the Architect/Engineer if any specified chemicals are prohibited.

1.6 WATER ANALYSIS

A. Sample feedwater to determine appropriate chemical treatment. Contact the Architect/Engineer if test indicates treatment required is different than that specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Nalco.

2.2 MATERIALS

A. Closed System Treatment (Water):

1. Proprietary blend containing the following items:

a. Corrosion Inhibitors for Heating Water System: Sodium nitrite-borax or molybdate with added inhibitors such as mercaptobenzothiazole, sodium tolytriazole, or phenyltriazole to protect copper and brass and minimize dielectric pitting of steel. Maintain 1,000 ppm nitrite or 100 ppm molybdate. Adjust borax content to keep correct pH for type of system (mainly steel or mainly copper).

b. Scale Inhibitor: Organic phosphonates such as aminomethylene-phosphonate; phosphonates such as hydroxyethylidenediphosphonate or polyamino-substituted phosphonates; or synthetic polymers such as low-molecular-weight polyacrylates, poly-methacrylates and polyacrylanides. Inorganic phosphates are not acceptable. Maintain residual concentration as recommended by the manufacturer.

2.3 EQUIPMENT

A. Bypass (Pot) Feeder: 5.0 gal; quick-opening cap with 3-1/2” minimum diameter opening and opening wrench, drain valve, air cock, working pressure of 200 psig at 200°F. Acceptable Manufacturers: Griswold, Vector Industries, J.L. Wingert, or Neptune.

B. Water Meter: Positive displacement type meter with bronze housing. 3/4" meter size. Meter to handle 1/2 - 30 GPM.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install bypass (pot) feeder with top approximately 36” above the floor.

C. Coordinate with Contractor to provide temporary metering capabilities during system fill to determine overall system volume. Notify Architect/Engineer of overall system volume so that expansion tank sizing can be confirmed.

3.2 CLOSED SYSTEM TREATMENT (WATER, GLYCOL AND CLOSED STEAM SYSTEMS UP TO 15 PSIG)

A. Provide one bypass feeder on each system. Install inlet, outlet and drain valves, and necessary piping.

B. Provide a 3/4" water meter in the domestic cold water line that provides make-up water.

C. Introduce treatment through bypass feeder. Test water systems semi-annually and steam systems monthly during warranty period and add additional chemicals, as required, to maintain the specified residual concentrations.

END OF SECTION 23 25 00

SECTION 23 31 00 - DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

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

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

A. ADC Flexible Duct Performance and Installation Standards, 3rd 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. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.

F. ASTM A90 - Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

G. ASTM A167- Stainless & Heat-Resisting Chromium-Nickel Steel Plate, Sheet, & Strip.

H. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

I. ASTM A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

J. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

K. ASTM E90-02 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

L. ASTM E413-87 - Classification for Rating Sound Insulation.

M. AWS D9.1M/D9.1 - Sheet Metal Welding Code.

N. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.

O. NFPA 90B - Installation of Warm Air Heating and Air- Conditioning Systems.

P. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Equipment.

Q. SMACNA – Air Duct Leakage Test Manual – 1985 Edition.

R. SMACNA - HVAC Duct Construction Standards - 2005 Edition.

S. SMACNA - Round Industrial Duct Construction Standards - 1999 Edition.

T. UL 181 - Factory-Made Air Ducts and Air Connectors.

U. UL 181A - Closure Systems for Use With Rigid Air Ducts and Air Connectors

V. UL 181B - Closure Systems for Use With Flexible Air Ducts and Air Connectors.

W. USGBC - Leadership in Energy and Environmental Design (LEED) Rating System.

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 ALUMINUM DUCTWORK

A. General Requirements:

1. Material: ASTM B209; aluminum sheet, Alloy 3003-H14. Aluminum connectors and bar stock: Alloy 6061-T6. Aluminum or stainless steel fasteners are acceptable.

2. All duct gauges and reinforcement shall be as called for in Tables 2-50, 2-51, 2-52, and 3-14 of the SMACNA HVAC Duct Construction Standards.

3. Ductwork reinforcement shall be of aluminum.

4. Ductwork supports shall be of aluminum, galvanized steel or painted steel. Slip cable hangers are acceptable. Acceptable manufacturers are Gripple, Ductmate, Duro Dyne, or Architect/Engineer approved.

5. All other requirements are as noted for galvanized rectangular sheet metal duct.

2.3 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.

2.4 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. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30°F to +175°F and 2000 hour minimum UV resistance per ASTM G-53.

B. Joint sealers shall meet the volatile organic compound (VOC) limits of U.S. Green Building Council LEED credit EQ 4.1, Low-Emitting Materials - Adhesives & Sealants (follow the latest edition at the time of bidding or as referenced in these specifications).

2.5 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. Type 2:

1) **Description**: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.

2) **Usage**: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48” long.

c. Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.

d. Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.

e. 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. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.

7. 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.

8. 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.

9. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.

10. 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.

11. 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.

2.6 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 perforated galvanized interior wall: Interior galvanized surfaces shall have round perforations. Inner liner shall have a film between the insulation and the perforated interior wall to prevent air contact with the insulation.

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 1" 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".

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 ROUND DUCTWORK - SINGLE WALL

A. Conform to applicable portions of Rectangular Duct Section. Round 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. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.

D. 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.

E. Ductwork shall be suitable for velocities up to 5,000 fpm.

F. 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.

G. 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.

H. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.

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”).

2.8 EXPOSED DUCTWORK (RECTANGULAR, ROUND, AND FLAT OVAL)

A. The following applies to all ductwork exposed in finished areas in addition to requirements noted above:

1. Provide extra shipping protection. Use Cardboard or other protective means to prevent dents and deformed ends.

2. Provide cardboard or other means of protection during field fabrication. Protect from scratches. Provide stiffeners to retain shape during fabrication.

3. Remove all identification stickers and thoroughly clean exterior of all ducts.

4. Locate fitting seams on least visible side of duct.

5. Provide exterior finish suitable for field painting without further oil removal.

6. Provide ramp-type internal joint couplings. Provide bead of sealant around the inside of the duct about 1/2” from the end of the duct. Slide-on flanges as manufactured by Ductmate Industries, Accuflange or Sheet Metal Connectors are acceptable. Self-sealing duct system is also acceptable (Lindab, Ward “Keating Koupling”).

7. The system shall be free of visible dents and scratches when viewed from normal occupancy.

8. All insulation shall be internal, except at reheat coils.

9. All spiral ductwork fittings shall be carbon arc welded.

10. Grind all welds to remove irregularities.

11. Conical taps shall be one piece. Taps for grilles and takeoffs shall be factory installed with a continuous weld and ground smooth.

12. Welds shall be ground smooth and painted.

13. All exposed ducts shall be round except where not possible (grilles, reheat coils, etc.).

B. Alternate manufacturers, including shop fabricated duct, must be reviewed before installation. The following information is required:

1. Metal gauge of duct and fittings.
2. Fitting type and construction.
3. Type and size of reinforcement.

2.9 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 ft2*ºF*hr/Btuh. Temperature range of at least 0-180ºF. 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 <u>not</u> acceptable.

2.10 ACOUSTICAL LAGGING

A. Type A: Lagging shall be a loaded vinyl noise barrier, fiberglass scrim facing, and 2" thick quilted fiberglass decoupling layer. Lagging shall have a minimum STC of 30, and Class A flammability (maximum 25/50) rating per ASTM E-84. Install lagging per manufacturer's recommendations.

1. Acceptable Products: Sound Seal B-10 Lag/QFA-9, McGill Air Pressure PDL-9.

B. Provide acoustical lagging for all supply and return ductwork from the roof penetration at an RTU to the downstream end of the duct silencer.

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. Supply ductwork shall be free of construction debris, and shall comply with level “B” of the SMACNA Duct Cleanliness for New Construction Guidelines.

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. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.

H. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.

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)
Supply Duct from Fan to Terminal Air Boxes – Single Wall	Galvanized Sheet Metal - Rectangular	+3"	A	1-1/2" thick Type A
Supply Duct from Fan to Terminal Air Boxes – Single Wall	Galvanized Sheet Metal - Round	+3"	A	1-1/2" thick Type A
Supply Duct from Fan to Terminal Air Boxes	Galvanized Sheet Metal w/Slide-On Flange System or Formed-on Flanges	+3"	A	1-1/2" thick Type A
Fieldhouse Supply Duct from Fan to Fabric Duct Connection - Double Wall	Galvanized Sheet Metal - Rectangular	+3"	A	1" thick Type E
Fieldhouse Supply (where noted on the drawings)	Fabric (refer to section 23 31 01 for requirements)	---	---	---
Supply Duct from Terminal Air Boxes to Outlets	Galvanized Sheet Metal - Rectangular	+2”	A	1" thick Type C

USAGE	MATERIAL	PRESSURE CLASS	SEAL CLASS †	INSULATION (Refer to Section 23 07 13 for insulation types)
Supply Duct from Terminal Air Boxes to Outlets	Galvanized Sheet Metal - Round	+2”	A	1" thick Type G
Return Duct	Galvanized Sheet Metal	-2"	A	1" thick Type C
General Exhaust Duct - no connected Inlets serving a Locker Room or Shower	Galvanized Sheet Metal	-1"	A	None
General Exhaust Duct - with connected Inlets serving Locker Rooms or Showers	Aluminum Sheet Metal	-1"	A	None
Combustion Air Duct	Galvanized Sheet Metal	-1"	A	2" thick Type B
Transfer Ducts - no Air Transferred to or from a Locker Room or Shower	Galvanized Sheet Metal	-1/2"	---	1" thick Type C
Transfer Ducts - with Air Transferred to or from a Locker Room or Shower	Aluminum Sheet Metal	-1/2”	---	None
Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.)	---	---	---	1-1/2” thick Type A
All Terminal Air Box/ Reheat Coil Headers and Duct Mounted Coil Headers	--	--	---	1-1/2” thick Type A
† 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. 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.

3. 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.

C. Double-wall ductwork: Install insulation end fittings at all transitions from double to single-wall construction.

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. Duct - 3" WG and Above (positive or negative):

1. A minimum of 25% of interior ductwork shall be tested. The Owner or designated representative shall select the sections to be tested. If duct has outside wrap, testing shall be done before it is applied.

2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.

3. Seal ducts to bring the air leakage into compliance.

4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

C. 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.

3.6 PAINTING

A. Paint interior of ducts black within twice the largest duct dimension of inlets and outlets where interior of duct is visible.

B. Paint bottom of ducts black within twice the largest duct dimension where a duct is routed above an unducted perforated grill and the duct is visible.

END OF SECTION 23 31 00

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SECTION 23 31 01 - FABRIC DUCTWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of non-metal ductwork is indicated on drawings and by requirements of this section.

B. Types of non-metal ductwork required for this project include the following:

1. Textile air Dispersion Products.

1.2 QUALITY ASSURANCE:

A. Building Codes and Standards:

1. Product must be classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and UL 2518.

2. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.

B. Design & Quality Control

1. Manufacturer must have documented design support information including duct sizing; vent, orifice, and/or nozzle location; vent, orifice, and/or nozzle sizing; length.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work of this section.

B. Building Code Data: Submit UL file number under which product is Classified by Underwriter's Laboratories NFPA 90, ICC AC167 and UL 2518.

1.4 WARRANTY

A. Manufacturer must provide a 15 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Protect textile air dispersion systems from damage during shipping, storage and handling.

B. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

PART 2 – PRODUCTS

2.1 TEXTILE AIR DISPERSION SYSTEM:

A. Textile Construction: Filament/filament twill polyester treated with a machine washable anti-microbial agent by the fabric manufacturer, fire retardant in accordance with UL 2518. Non-linting filament yarn to meet the requirements of ISO Class 3 environment.

1. Weight: 6.8 oz. /yd^2 per ASTM D3776

2. Color: Coordinate with the architect.

3. Air Permeability: 2 (+2/-1) CFM/ft^2 per ASTM D737, Frazier.

B. SYSTEMS FABRICATION REQUIREMENTS:

1. Textile system to be constructed in modular lengths (zippered) with proper radial securing clips (inlets, endcaps) and top access zippers for tension lock attachments.

2. Integrated air dispersion shall be specified and approved by manufacturer.

a. Linear Vents

1) Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on .5" SP), starting a 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.

2) Size of vent openings and location of linear vents to be specified and approved by manufacturer.

3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.

4. Inlet connection includes zipper for easy removal / maintenance.

5. Lengths to include required intermediate zippers as specified by manufacturer.

6. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.

7. End cap includes zipper for easy maintenance.

8. Each section of the textile shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.

C. DESIGN PARAMETERS:

1. Textile air diffusers shall be designed from 0.25" water gage minimum to 3.1" maximum, with 0.5" as the standard.

2. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F.

D. SUSPENSION HARDWARE:

1. SkeleCore Pull-Tight System: Air diffusers shall be constructed with both internal retention and external tensioning.

a. System shall consist of internal tensioning baskets with cable or track stops that externally tension the system off of the suspension system selected below along with 360 degree internal retention hoops that are spaced 5’ on center between tensioning baskets.

b. Tensioning baskets are designed to self-lock when tension is applied to the system.

c. All straight sections utilize both internal retention hoops and external tensioning with the use of the tension baskets.

d. Distance between consecutive tensioning baskets should not be more than 40’.

e. System shall be installed with a one row suspension system located 1.5” above top-dead-center of the textile system.

f. System attachment to cable shall be made using Gliders spaced no further than 12 inches apart.

1) Cable suspension hardware to include cable, eye bolts, thimbles, cable clamps, and turnbuckle(s) as required.
a) Cable suspension

2) Galvanized steel cable
a) Support lengths available in 5’

E. ACCEPTABLE MANUFACTURER

1. DuctSox Corporation.

a. Sedona-Xm textile.
b. SkeleCore Pull-Tight suspension system.

PART 3 - INSTALLATION

3.1 INSTALLATION OF TEXTILE AIR DISPERSION SYSTEM:

A. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

3.2 CLEANING AND PROTECTION:

A. Clean air handling unit and ductwork prior to the fabric duct system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.

END OF SECTION 23 31 01

SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manual Volume Dampers.
B. Fire Dampers.
C. Fabric Connectors.
D. Duct Access Doors.
E. Duct Test Holes.
F. Duct Silencers.

1.2 REFERENCES

A. ASTM E477-06a - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

B. ASTM E2336-04 – Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems.

C. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.

D. SMACNA - HVAC Duct Construction Standards – Third Edition - 2005.

E. UL 33 - Heat Responsive Links for Fire-Protection Service.

F. UL 555 - Fire Dampers and Ceiling Dampers.

G. UL 555C – Ceiling Dampers.

H. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 05 00.

B. Submit manufacturer's installation instructions.

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.

2.2 DYNAMIC CURTAIN BLADE FIRE DAMPERS (FD)

A. Furnish and install fire dampers in ducts, where shown on the drawings, at the point where they pass through a fire wall or a floor and in all other locations required by the local fire department, The National Fire Protection Association's Pamphlet No. 90A and all other applicable codes.

B. Fire dampers shall be UL 555 listed for 1-1/2 hour fire resistance unless noted otherwise, dynamic rated with heated airflow at 2,000 fpm and 4" WC, and have all blades stacked out of the airstream (Type B).

C. Where dampers are located in aluminum or stainless steel duct, provide stainless steel dampers.

D. Fire dampers shall be held open by a fusible link rated at 165ºF unless otherwise called for on the drawings or by local codes.

E. Dampers shall be installed in sleeves of sufficient thickness to permit rigid duct connections. The sleeve shall be a minimum of 16 gauge for dampers up to 36" wide by 24" high and 14 gauge for dampers exceeding 36" wide by 24" high. Damper sleeve shall not extend more than 6" beyond the firewall or partition unless damper is equipped with a factory installed access door. Sleeve may extend up to 16" beyond the firewall or partition on sides equipped with the factory installed access door.

F. Locate access door in the ductwork for visual inspection and on the latch side to replace link easily. Each access door shall have a label with letters at least 1/2" high, reading "FIRE DAMPER".

2.3 DUCT SILENCERS

A. Straight Silencer

1. All silencers shall be factory fabricated by the same manufacturer, except that ‘No-Loss” silencers (thicker than normal double-wall ducts) may be Contractor fabricated.

2. Duct silencers shall have length, air pressure drop, and self-generated sound ratings not to exceed the values scheduled on the drawings. Dynamic insertion ratings shall not be less than those scheduled on the drawings. Silencer inlet and outlet dimensions must match the sizes on the drawings. Transitions are not acceptable unless shown on the drawings.

3. All silencer ratings shall be determined in accordance with the ASTM E477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

4. Silencers shall be constructed of galvanized steel, have 26 gauge minimum perforated interior (22 gauge for transitional silencers), be able to withstand 8" of

positive and 4" of negative pressure, and shall have inorganic, bacteria, and fungus resistant glass fiber filler with not less than 5% compression. Silencers shall meet SMACNA standards for the duct pressure class specified.

5. Fiberglass cloth or other scheduled liners shall completely separate the media from the airstream. No-media silencers shall not contain absorptive packing of any kind.

6. Silencers shall not exceed 25/50 flame spread/smoke developed per ASTM E84, NFPA 255, or UL 723.

7. Acceptable Manufacturers: Vibro-Acoustics, VAW, United McGill, Semco, Ruskin Sound Control (Rink), AeroSonics, Dynasonics, Price. All silencers shall be by the same manufacturer.

B. Elbow Silencer

1. All silencers shall be factory fabricated by the same manufacturer, except that 'No-Loss" silencers (thicker than normal double-wall ducts) may be Contractor fabricated.

2. Duct silencers shall have length, air pressure drop, and self-generated sound ratings not to exceed the values scheduled on the drawings. Dynamic insertion ratings shall not be less than those scheduled on the drawings. Silencer inlet and outlet dimensions must match the sizes on the drawings. Transitions are not acceptable unless shown on the drawings

3. All silencer ratings shall be determined in accordance with the ASTM E477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

4. Silencers shall be constructed of galvanized steel with an 18 gauge galvanized steel outer casing and 22 gauge galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48 shall have at least two half splitters and one full splitter. Silencers shall be able to withstand 8" of positive and 4" of negative pressure, and shall have inorganic, bacteria, and fungus resistant glass fiber filler with not less than 5% compression. Silencers shall meet SMACNA standards for the duct pressure class specified.

5. Fiberglass cloth or other scheduled liners shall completely separate the media from the airstream. No-media silencers shall not contain absorptive packing of any kind.

6. Silencers shall not exceed 25/50 flame spread/smoke developed per ASTM E84, NFPA 255, or UL 723.

7. Acceptable Manufacturers: Vibro-Acoustics, VAW, United McGill, Semco, Ruskin Sound Control (Rink), AeroSonics, Dynasonics, Price. All silencers shall be by the same manufacturer.

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”.

5. Provide duct test holes where indicated and as required for testing and balancing purposes.

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.

3. Grease duct volume dampers shall be continuously welded to duct and/or hoods so that system is liquidtight.

C. Fire Damper:

1. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves and duct connections.

2. Provide ceiling access doors for fire dampers. Coordinate location with the Architect/Engineer.

3. Demonstrate resetting of fire dampers to authorities having jurisdiction and Owner's representative.

4. At fire dampers where duct is:

a. Internally insulated, exterior duct wrap shall be installed from the wall out to 1 foot from the wall. All edges shall be taped.

b. Externally insulated, the exterior duct wrap shall extend up to the wall.

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.

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. Furnish permanently lubricated sealed ball type motor and drive shaft bearings sized for 200,000 hours life at specified operating conditions. Drives sized for 150% of rated motor horsepower. Drive assembly and wheel supported by vibration isolators.

M. Acceptable Manufacturers: Aerovent "FACX", Cook "ACE-B", Greenheck "GB", Carnes "VEB", Penn DX, ACME PV, or ILG CRB, Twin City BCRD.

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 ROOFTOP FAN CURBS

A. Furnish and install prefabricated roof curbs for all rooftop fans.

B. Size curb to match the curb cap of fan.

C. Top of all curbs shall be at least 24" above the top of the roof. Increase curb height to allow for roof insulation.

D. Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer.

E. If called for in the drawings, curbs shall be of the sound attenuation type. Sound attenuation curbs shall reduce the fan sone rating by at least 40% and not decrease fan cfmmore than 8% (which is accounted for in the scheduled fan cfm). Baffles shall be removable for access to the dampers.

F. 18-gauge galvanized steel construction.

G. Curb without cant.

H. Acceptable Manufacturers: Same manufacturer as the fan, Pate, RPS or Thy.

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 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Single Duct Variable Air Volume Terminal Box.

1.2 REFERENCES

A. NFPA 90A - Installation of Air-Conditioning and Ventilation Systems.

B. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 05 00.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.

D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.

E. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

C. Include directions for resetting constant volume regulators.

PART 2 - PRODUCTS

2.1 ACOUSTICAL CONSIDERATIONS (THIS APPLIES TO ALL UNITS)

A. All units shall have noise data certified in accordance with ARI Standard 885-98 with 5/8” 20-lb. density mineral fiber ceiling tile and shall not produce space noise values over NC-35 due to radiated and airborne noise combined. Noise in classrooms shall not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002.

2.2 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX

A. Casing: Minimum 22 gauge galvanized steel. Fully lined with minimum 1”, minimum 1-1/2 pound density fiberglass insulation. Insulation shall be UL listed and meet NFPA 90A requirements.

B. All insulation in contact with the air stream shall be foil faced, UL listed and NFPA 90A approved.

C. Damper Blade: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.

D. Damper Operators: Electronic, furnished and installed by TCC. Refer to Section 23 09 00 for additional information.

E. DDC Volume Controller: Electronic, furnished and installed by TCC. Boxes to be pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. Provide velocity and static sensor at inlet to box for use by unit controller. Boxes shall be set for maximum and minimum settings shown on the drawings. Refer to Section 23 09 00 for additional information.

F. Hot Water Coils: Copper tubes, aluminum fins, minimum 0.016" wall thickness, leak tested at 300 psig. Air pressure drop shall not exceed scheduled value. Provide access door or removable panel for access to the upstream side of the heating coil. Capacity shall be as scheduled on the drawings. Hot water control valve shall be by the TCC.

G. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings.

H. Refer to control diagrams and notes on control drawings for complete sequence of control.

I. Acceptable Manufacturers: Carrier, Titus, Trane, Krueger, Carnes, E.H. Price, Tuttle & Bailey, Nailor, Enviro-Tec, Johnson Controls Inc., Metalaire.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide ceiling access doors or locate units above easily removable ceiling components.

C. Support units individually from structure. Do not support from adjacent ductwork.

D. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.

E. Comb fins on coils to repair bent fins.

F. Insulate terminal air box reheat coils to prevent condensation. Tape insulation tight to box. Do not insulate the box itself to prevent interference with actuator, access panel and control panel.

3.2 ADJUSTING

A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION 23 36 00

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.

1.3 REFERENCES

A. AMCA 500L-07 - Test Method for Louvers, Dampers and Shutters.

B. ANSI/ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Inlets and Outlets.

C. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ASHRAE 170 (latest published edition) - Ventilation of Health Care Facilities.

E. 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.

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 51 00 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Gas Vents.

1.2 REFERENCES

A. ANSI Z181.1 (UL 959) - Medium Heat Appliance Factory Built Chimneys.

B. ANSI Z21.66 - Electrically Operated Automatic Vent Damper Devices for Use with Gas-Fired Appliances.

C. ANSI Z223.1 (NFPA 54) - The National Fuel Gas Code.

D. ANSI/ASTM C64 - Refractories for Incinerators and Boilers.

E. ANSI/UL 103 - Standard for Factory Built Chimneys for Residential Type and Building Heating Appliances.

F. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.

G. UL 378 - Standard for Draft Equipment

H. UL 441 - Standard for Gas Vents.

I. UL 641 - Standard for Type L Low-Temperature Venting Systems.

1.3 SUBMITTALS

A. Submit shop drawings per Section 23 05 00. Include general construction, dimensions, weights, support and layout of breechings. Where factory built units are used submit layout drawings indicating plan view and elevations.

B. Submit product data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights.

C. Submit engineering report and manufacturer's certificate that refractory lined metal stacks meet specified requirements.

D. Submit manufacturer's installation instructions.

1.4 DEFINITIONS

A. Vent: Conveys flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

1.5 DESIGN REQUIREMENTS

A. Factory built vents and chimneys used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labeled.

PART 2 - PRODUCTS

2.1 POSITIVE PRESSURE GAS VENTS (CONDENSING AND HIGH EFFICIENCY)

A. The venting system shall be ANSI/UL 1738.

B. The venting system shall be double wall metal with a minimum of 1” air space between the walls. Outer wall shall be Type 430 stainless steel.

C. The inner pipe shall be AL29-4C.

D. Vent flue pipe shall be UL listed for Category III and IV appliances with operating temperatures of up to 480°F. The closure system to be rated as gas tight for 5” w.c. positive pressure flue gas service.

E. Fasteners to be same material as piping and shall maintain 1” air space between walls.

F. The joints shall be gas tight to prevent leakage of flue or condensate.

G. Vent system is to be sized in accordance with manufacturer’s recommendations and the current edition of NFPA 54/ANSI Z223.1: National Fuel Gas Code and ASHRAE recommendations.

H. Furnish roof flashing and cap.

I. Acceptable Manufacturers: Heat-Fab “Saf-T Vent CI Plus”, DuraVent “FasNSeal W2”, Metal-Fab “Corr/Guard”, Schebler “eVent”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prior to putting boilers into operation, Contractor shall provide full penetration welds for the entire length of each pipe section for all inner and outer shell seams to prevent leakage of flue gases. Riveted, tack, or spot welded seams are not permitted.

B. Install all products in accordance with manufacturer's instructions.

C. Install in accordance with recommendations of ASHRAE - Handbook, Chapter "Chimney, Gas Vent, and Fireplace Systems", NFPA 211, and ANSI Z223.1 (NFPA 54).

D. Clean stacks during installation, removing dust and debris.

E. Provide slip joints permitting removal of appliances without removal or dismantling of stacks.

END OF SECTION 23 51 00

SECTION 23 52 16 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Boilers.
B. Controls and Boiler Trim.
C. Hot Water Connections.
D. Fuel Burning System and Connection.
E. Vent Connection.
F. Boiler Vent Flue.

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with at least three years documented experience.

B. Provide factory authorized start-up service by manufacturer's agent.

C. Conform to ANSI/ASME SEC 4 and ANSI/AGA Z21.13 for construction of boilers.

D. Boiler Units: AGA certified, UL listed and ASME certified.

E. Installation shall meet the requirements of ASME CSD-1 NFPA 85, including remote emergency shutdown switches for boilers, applicable gas train, individual venting of gas regulators, and repackable shutoff valves at all boilers.

F. Conform to ASHRAE 90.1.

1.3 REFERENCES

A. AGA - Directory of Certified Appliances and Accessories.

B. ANSI/AGA Z21.13 - Gas-Fired Low-Pressure Steam and Hot Water Boilers.

C. ANSI/AGA Z223.1 - National Fuel Gas Code.

D. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. ANSI/ASME SEC 4 - Boiler and Pressure Vessels Code - Rules for Construction of Heating Boilers.

F. ANSI/ASME SEC 8D - Boilers and Pressure Vessels Code - Rules for Construction of Pressure Vessels.

G. ANSI/NFPA 70 - National Electrical Code.

H. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers.

I. NFPA 85 - Boiler and Combustion Systems Hazard Code.

1.4 SUBMITTALS

A. Submit product data under provisions of Section 23 05 00.

B. Submit product data indicating general assembly, components, controls, safety controls, and wiring diagrams, and service connections.

C. Submit manufacturer's installation instructions.

D. Submit reports indicating condition and operation at start-up.

E. Submit reports indicating specified performance and efficiency is met or exceeded.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data. Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

PART 2 - PRODUCTS

2.1 BOILERS

A. Provide factory assembled, factory fire-tested, self-contained unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.

B. Unit: Hot water, condensing type boiler with integral forced draft or pulse combustion burner, burner controls, boiler trim, insulation and jacket.

C. ASME allowable working pressure of 150 psig water.

D. Provide two lifting eyes on top of boiler.

E. Unit casing shall be a minimum of 16 gauge steel. Factory paint boiler, base, and other components with hard finish enamel.

F. Porcelain enameled or stainless steel exhaust manifold with gravity drain and reservoir for condensate elimination.

G. Acceptable Manufacturer: Fulton (Endura), Aerco International, Inc. (Benchmark), Thermal Solutions (EVCA), Raypak (Xtherm).

2.2 HEAT EXCHANGER

A. Condensing, fire tube design surrounded by water that is suitable for return water temperatures as low as 50ºF.

B. Seven-year prorated warranty against leakage due to thermal shock or corrosion.

2.3 BOILER FLUE

A. The boiler manufacturer shall review and approve vent size, type, and routing of all vent flue piping, fittings, dampers, and accessories as required to properly vent the equipment. Vent piping shall be UL listed for use with category III and IV appliances with operating temperatures of up to 480°F.

B. Refer to Section 23 51 00 for materials.

2.4 HOT WATER BOILER TRIM

A. Provide ASME safety relief valve set at 125 psi or boiler maximum allowable working pressure.

B. Provide low water cut-off with manual reset to automatically prevent burner operation whenever boiler water falls below safe level.

C. Provide operating temperature controller to control burner operation to maintain boiler water temperature, as determined by a remote 4-20 mA signal from building DDC system or boiler controller.

D. Limit temperature controller to control burner to prevent boiler water temperature from exceeding safe system water temperature.

E. Provide all trim required to meet ASME CSD-1 5. This includes, but is not limited to, gas train and all terminals and necessary relays for connection to remote shutdown switch(es) to disconnect all power to the burner controls.

2.5 FUEL BURNING SYSTEM

A. General: Forced draft automatic burner integral with boiler designed to burn natural gas at 8.5" to 14" W.C. inlet pressure. Maintain fuel-air ratios automatically.

B. Gas Burner: Forced draft, power burner with interrupted spark ignition and flame sensor.

C. Include on unit complete gas train including gas safety shutoff valve conforming to CSD-1 requirements. Vent all gas valves to outdoors separately.

D. Burner to be modulating with a minimum turndown ratio of 4:1.

2.6 CONTROL PANEL

A. The boiler system control panel shall include contacts for a trouble alarm to the DDC system.

B. Program relay to control ignition, starting and stopping of burner and provide both pre-combustion purge and post combustion purge. Burner to shut down in event of ignition, or main flame failure. Interlock to shut down burner upon combustion air pressure drop.

C. Manual-automatic selector switch to permit automatic firing in accordance with load demand, or manual control of firing rate at fixed temperature.

D. Panel to include indicating lights to show fault conditions of low water level, flame failure, fuel pressure, exhaust temperature, water temperature, or combustion air pressure. Mount indicating lights and switches in hinged drop-panel for access to wiring.

E. The boiler system control panel shall include contacts for a manual CSD-1 emergency shutdown switch. The switch shall be furnished, installed, and wired by the Electrical Contractor. Switch shall be located at each exit just outside the boiler room door or as shown on plans. If boiler room door is on exterior of building, the switch shall be located just inside the door or as shown on plans. Verify final location with Architect/Engineer. The switch shall disable all boilers and shall be wired to the boiler burner safety control

circuit to interrupt burner operation. If electrical plans and specifications do not show switch and wiring, the Mechanical Contractor shall furnish, install, and wire.

F. If boiler shutdown switch and associated wiring is not shown and specified on the electrical plans, the Mechanical Contractor shall provide. The boiler shutdown switch shall be an emergency stop, mushroom head with N.C. contact, turn to release switch with engraved nameplate to read “BOILER EMERGENCY SHUTOFF”. Square D XAL K174 or as approved by Architect/Engineer.

G. For multiple boiler systems, furnish a boiler management system consisting of controller(s) capable of stopping, starting, and modulating all boilers to maintain maximum efficiency of the boiler plant. The boiler management system shall include all alarms, control points, and setpoints specified.

2.7 PERFORMANCE

A. Minimum efficiency, verified by factory tests, shall be 86% at 100% output with 150°F return water and 88% at 25% output with 130°F return water.

B. Rated for return temperatures as low as 40°F and supply temperatures as high as 190°F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Requirements:

1. Install in accordance with manufacturer's instructions.

2. Provide for connection to electrical service.

3. Provide connection of gas service in accordance with ANSI/AGA Z223.1.

4. Pipe safety relief valve and condensate trap to nearest floor drain. Route condensate pipe to acid resistant floor drain.

B. Combustion Inlet and Venting:

1. Provide complete sealed combustion inlet and venting system.

2. Slope all horizontal runs of exhaust vent towards the boilers at a slope of 1” per 4’.

C. Service Clearance:

1. Install the boilers with a minimum of three feet clear space behind them for installation of piping and services. Verify exact maintenance clearances required by the manufacturer prior to installation.

3.2 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under factory authorized supervision.

B. Provide field representative for starting unit and training operator.

C. Provide combustion test and submit report. Test shall include boiler firing rate, overfire draft, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O_2), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent combustion efficiency, and heat output.

END OF SECTION 23 52 16

SECTION 23 74 11 - PACKAGED ROOFTOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Rooftop Unit.
B. Unit Controls.
C. 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. ARI 210 - Unitary Air Conditioning Equipment.

B. ARI 240 - Air Source Unitary Heat Pump Equipment.

C. ARI 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 five (5) year manufacturer’s warranty for heat exchanger.

C. Provide five (5) 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. Provide maintenance service with a two month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.

C. 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.

D. Submit copy of service call work order or report, and include description of work performed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Daikin.
B. York.
C. Trane.

2.2 MANUFACTURED UNITS

A. Provide roof-mounted units having gas burner, and electric refrigeration.

B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, exhaust fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil, condenser fan, and a full refrigerant charge.

C. 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. Unit cabinet shall be designed to operate at total static pressures up to 6.5 inches w.g.

B. Unit shall have heavy gauge solid galvanized steel double wall liners provided throughout, allowing no exposed insulation within the air stream. All cabinet insulation, except floor panels, shall be a nominal 2" thick, 1 ½ lb. density, R6.5, glass fiber. Floor panels shall include 1" thick, 3 lb. density, R4.2, glass fiber insulation.

C. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished surface to withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.

D. Service doors shall be provided on both sides of each section in order to provide user access to all unit components. Service doors shall be constructed of heavy gauge galvanized steel with galvanized steel interior liners. All service doors shall be mounted on multiple, stainless steel hinges and shall be secured by a stainless steel latch system that is operated by a single handle. The latch system shall feature a staggered engagement for ease of operation and a safety catch shall protect the user from injury in case a positive pressure door is opened while the fan is operating. Removable panels, or doors secured by multiple, mechanical fasteners are not acceptable.

E. The unit base frame shall be constructed of 13 gauge pre-painted galvanized steel.

F. The unit base shall overhang the roof curb for positive water runoff and shall have a formed recess that seats on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base with lifting holes to accept cable or chain hooks.

2.4 ROOF CURB

A. A vibration isolation curb sized for the unit shall be provided by the unit manufacturer. The curb interstitial space between the bottom of the unit and the roof below shall act as a supply/return plenum and a divider shall be capable of being located anywhere along the curb between the supply and return unit connections so separate the supply and return plenums. Coordinate the divider location with the installing contractor.

2.5 FANS/MOTORS

A. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide an L-50 life at 200,000 hours. The entire fan assembly shall be isolated from the fan bulkhead and mounted on rubber-in-shear isolators.

B. Fan motors shall be heavy-duty 1800 rpm premium efficiency. Fan motors to have grease lubricated ball bearings. Motors shall be mounted on an adjustable base that provides for proper alignment and belt tension adjustment.

C. Motor shall be Open Dripproof.

D. Airfoil supply fans.

1. Supply fan shall be a double width, double inlet (DWDI) airfoil centrifugal fan. All

fans shall be mounted using shafts and hubs with mating keyways. Fans shall be Class II type and fabricated from heavy-gauge aluminum. Fan blades shall be continuously welded to the back plate and end rim. Forward curved wheels are not acceptable.

E. Airfoil return fans.

1. A single width, single inlet (SWSI) airfoil centrifugal return air fan shall be provided. The fan shall be Class II construction. The fan wheel shall be Class II construction and fabricated from heavy-gauge aluminum with fan blades continuously welded to the back plate and end rim. The fan shall be mounted using shafts and hubs with mating keyways. Exhaust fans and/or forward curved wheels are not acceptable

2.6 VARIABLE AIR VOLUME CONTROL

A. Separate electronic variable frequency drives shall be provided for each fan. Drives shall be independent. Drives shall be cooled by the filtered mixed air stream. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly complete with a single handle latch mechanism. Mounting arrangements that expose drives to high temperature, unfiltered ambient air are not acceptable. The unit manufacturer shall install all power and control wiring.

B. The drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel. The supply and return/exhaust fan drive outputs shall be independently controlled in order to provide the control needed to maintain building pressure control. Supply and return/exhaust air fan drives that are slaved off a common control output are not acceptable.

C. All drives shall be factory run tested prior to unit shipment.

2.7 BURNER

A. A natural gas fired furnace shall be installed in the unit heat section. The heat exchanger shall include a type 321 stainless steel cylindrical primary combustion chamber, a type 321 stainless steel header, 321 stainless steel steel secondary tubes and type 321 stainless steel turbulators. Carbon or aluminized steel heat exchanger surfaces are not acceptable. The heat exchanger shall have a condensate drain. Clean out of the primary heat exchanger and secondary tubes shall be accomplished without removing casing panels or passing soot through the supply air passages. The furnace section shall be positioned downstream of the supply air fan.

B. The furnace shall be supplied with a forced draft burner capable of continuous modulation between 5% and 100% of rated capacity (20:1 turndown), without steps, and shall operate efficiently at all firing rates. The burner shall have proven open damper low-high-low prepurge cycle, and proven low fire start. The combustion air control damper shall be in the closed position during the off cycle to reduce losses. Burners with turndown than less than 20:1 capability are not acceptable.

C. The burner shall be specifically designed to burn natural gas and shall include a microprocessor based flame safeguard control, combustion air proving switch, pre-purge timer and spark ignition. The gas train shall include redundant gas valves, shutoff cock, pilot gas valve, pilot pressure regulator, and pilot cock.

2.8 EVAPORATOR COIL

A. The cooling coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with factory piped cooling coil and sloped drain pan. Hinged access doors on both sides of the section shall provide convenient access to the cooling coil and drain pan for inspection and cleaning.

B. Direct expansion (DX) cooling coils shall be fabricated of seamless 1/2" diameter high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design. All units shall have two independent refrigerant circuits and shall use an interlaced coil circuiting that keeps the full coil face active at all load conditions.

C. All coils shall be factory leak tested with high pressure air under water.

D. A stainless steel, positively sloped drain pan shall be provided with the cooling coil. The drain pan shall extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall be connected to a threaded drain connection extending through the unit base. Units with stacked cooling coils shall be provided with a secondary drain pan piped to the primary drain pan.

2.9 CONDENSING SECTION

A. Air Cooled Condenser

1. Units shall have at least one condenser fan controlled to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45º F ambient. .

2. Units shall have at least one condenser fan controlled to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45º F ambient. SpeedTrol™ condenser fan speed control shall be added to the last fan off on each refrigeration circuit to provide cooling operation to ambient temperatures down to 0° F. Fan speed control shall be field adjustable..

3. The condensing section shall be open on the sides and bottom to provide access and to allow airflow through the coils. Condenser coils shall be multi-row and fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.

4. Condenser fans shall be direct drive, propeller type designed for low tip speed, vertical air discharge, and include service guards. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.

B. Scroll Compressors

1. Each unit shall have multiple, heavy-duty Copeland scroll compressors.

2. Each compressor shall be complete with gauge ports, crankcase heater, sight-glass, anti-slug protection, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure.

3. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.

C. Refrigeration Circuit

1. Each unit shall have two independent refrigeration circuits. Each circuit shall be complete with low pressure control, pumpdown switch, liquid line solenoid valve, filter drier, liquid moisture indicator/sight-glass, thermal expansion valve, liquid line charging valve with a 3/8" charging port, a manual reset high pressure safety switch. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation. Each circuit shall be dehydrated and leak tested. Unit shall have discharge and suction line shutoff valves.

2. Each circuit shall be dehydrated and factory charged with 410-A Refrigerant and oil. Refrigeration capacity control shall be accomplished by staging of the unit's multiple compressors. All compressor capacity control staging shall be controlled by the factory installed main unit control system.

D. Hot gas bypass control shall be factory installed on one refrigerant circuits. Hot gas bypass control shall include a modulating hot gas bypass control valve, integral solenoid valve, all associated piping and be automatically operated by the units microprocessor control

2.10 MIXING SECTION

A. Unit shall be provided with an outdoor air economizer section. The 0 to 100% outside air economizer section shall include outdoor, return, and exhaust air dampers. Outdoor air shall enter from both sides of the economizer section through horizontal, louvered intake panels complete with rain lip and bird screen. The floor of the outdoor air intakes shall provide for water drainage. The economizer section shall allow return air to enter from the bottom of the unit. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be opposed sets of parallel blades, arranged vertically to converge the return air and outdoor air streams in multiple, circular mixing patterns.

B. Dampers and damper actuators shall meet the requirements of section 23 09 00.

C. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of foreign materials. Exhaust damper blades shall be lined with urethane gasketing on contact edges.

D. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. An electric actuator shall provide positive closure of the exhaust damper. A bird screen shall be provided to prevent infiltration of foreign materials. Exhaust damper blades shall be lined with urethane gasketing on contact edges.

E. Control of the outdoor or return dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating, spring return type. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling.

2.11 FILTERS

A. Unit shall be provided with a draw-through filter section. The filter section shall be supplied complete with the filter rack as an integral part of the unit. The draw-through filter section shall be provided with cartridge filters.

B. 12" deep 90-95% efficient, UL Std. 900, Class 1, cartridge filters shall be provided. 2" panel, 30% efficient MERV 8 pre-filters shall be included. Cartridge filters shall consist of filter media permanently attached to a metal frame and shall slide into a gasketed, extruded aluminum rack contained within the unit. The filter rack shall have secondary gasketed, hinged end panels to insure proper sealing. Filters shall be accessible from both sides of the filter section.

2.12 ELECTRICAL

A. Provide with single point power connection, disconnect, transformer, and convenience outlet. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect.

B. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.

C. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.

D. All units shall include a transformer for controls and convenience outlet.

E. Only one power cable connection to the unit shall be necessary.

2.13 OPERATING CONTROLS - VARIABLE VOLUME UNITS

A. 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 23 09 00. Control module shall be capable of completing the sequence of operations as described on the drawings.

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 71 11

SECTION 23 81 21 - COMPUTER ROOM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Split System Cooling Unit.

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.

I. USGBC - Leadership in Energy and Environmental Design (LEED) Rating System.

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. Mitsubishi
2. Daikin.
3. Trane.

B. Performance:

1. Refer to the drawings for performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that flooring system is ready to receive work and opening dimensions are as indicated on shop drawings and instructed by the manufacturer.

B. 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 condensate and humidifier flushing system.

2. Install condensate pump if required to remove condensate and humidifier blow down. 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. Panel Radiation.
B. Unit Heaters.
C. Cabinet Heaters.
D. Radiant Ceiling Panels.

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 PANEL RADIATION - WALL HUNG

A. All components shall be steel.

B. With corrugated fins welded to flat horizontal tubes to connect to vertical headers at each end.

C. Headers with inlet, outlet, vent and drain connections, and baffles for even heat distribution.

D. Provide integral all-welded 11 gauge perforated top grille.

E. Rated for 56 psi working and 74 psi test pressure.

F. Rated per ISO 1503147-3150.

G. Units to have gloss powder-coated finish. Color selection, from the Runtal color offerings, by the Architect. Furnish color charts with shop drawings.

H. Install mounting hardware per manufacturer's recommendations. Conceal all mounting hardware.

I. Acceptable Manufacturer: Runtal, Rittling, Vulcan, Sterling.

2.2 UNIT HEATERS

A. Casings shall be heavy gauge steel with a baked finish.

B. Coils shall have copper heads and tubes, and aluminum fins.

C. Units shall have threaded pipe connections for hanger rods.

D. Fans shall be direct drive propeller type, factory balanced, with fan guards and totally enclosed motors with integral thermal overload protection.

E. Horizontal units shall have adjustable outlet air louvers.

F. Acceptable Products: Trane - S or P, Daikin/McQuay - UHH or UDH, Modine - HS or V, Vulcan - HV or VV, Sterling HS or VS, Rittling - H or V, Sigma H or V, Airtherm HA or VA.

2.3 HOT WATER 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.

2.4 RADIANT CEILING PANELS (EXTRUDED)

A. Panel: 0.10" extruded aluminum panel. Panel sizes and mounting shall be per the drawings. Contractor to coordinate ceiling types with Architectural drawings.

B. Pipe: 0.50" I.D. nominal copper pipe factory installed in preformed U-shaped channels on the back of the panel.

C. Insulation: 1" thick, 0.75 lb/ft^3 fiberglass insulation provided with the panel.

D. Finish: Face to be flat with two coats of baked enamel paint. Paint color to be white.

E. Performance: Refer to drawings for performance data.

F. Panels to be connected together with copper tube "loops" per manufacturer's recommendation. Loops furnished by Mechanical Contractor.

G. Acceptable Manufacturers: Aerotech, Airtex, Airtite, Sun-El.

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. Unit Heater:

1. Hang unit heaters from building structure, not from piping. Mount as high as possible within manufacturer's recommended mounting height requirements. If unit heaters cannot be installed within manufacturer's recommended range, notify Architect/Engineer prior to mounting.

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. Electrical power system to and including light fixtures, equipment, motors, devices, etc.

2. Electrical power service entrance equipment, distribution and metering.

3. Grounding system.

4. Fire alarm system.

5. Removal work and/or relocation and reuse of existing systems and equipment.

6. 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 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.

1.5 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. 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 City of Joliet, Illinois 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.

6. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

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.

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, bus duct, fittings, etc.

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:

Referenced Specification Section	**Submittal Item**
26 05 15	Medium Voltage Cable and Accessories
26 05 33	Conduit and Boxes (Floor Box Only)
26 05 73	Power System Study
26 09 16	Electrical Controls and Relays
26 12 19	Pad-Mounted, Liquid-Filled Transformers
26 22 00	Dry Type Transformers

Referenced Specification Section	Submittal Item
26 24 13	Switchboards
26 24 16	Panelboards
26 24 19	Motor Control
26 27 26	Wiring Devices
26 28 16	Disconnect Switches
26 28 21	Contactors
26 29 23	Variable Frequency Drives
26 35 00	Power Conditioners
26 36 00	Transfer Switch
26 43 00	Surge Protection Devices
26 51 00	Lighting
26 55 61	Stage/Field House Lighting Control
26 55 62	Stage Lighting Rigging Hoist System
28 31 00	Fire Alarm and Detection System
Drawings	Stage Lighting Wire Guard

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.

1.8 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. Each piece of equipment requiring shop drawings. Use the equipment nomenclature (SB-1, PANEL P-1, etc.) on the Schedule of Values.
b. Each type of small unitary equipment (e.g., FDS, FCS, CS, etc.). Multiple units of the same type can be listed together provided quantities are also listed so unit costs can be determined.
c. Each conduit system (medium voltage, normal, emergency, low voltage systems, etc.). In addition, for larger projects breakdown the material and labor for each conduit system based on geography (building, floor, and/or wing).
d. Fire alarm broken down into material and labor for the following:
    1) Engineering
    2) Controllers, devices, sensors, etc.
    3) Conduit
    4) Wiring
    5) Programming
    6) Commissioning
e. Site utilities (5' beyond building)
f. Testing
g. Commissioning

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.

1.9 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.

1.10 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.

1.11 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.

1.12 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.13 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.

1.14 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.

1.15 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) and provide all services necessary for compliance with US Green Building Council LEED Prerequisite EAc1, and EAc3 Enhanced Commissioning.

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 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, compacting, and restoration in connection with his work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.

2. If excavations are carried in error below indicated levels, 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 under the foundation. 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. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.

9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.

10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.

11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.

12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.

C. Dewatering:

1. 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, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.

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. Furnish 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, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.

5. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.

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. Spread fill and backfill materials in 6” uniform horizontal layers with each layer compacted separately to required density.

7. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.

8. Conduits that are concrete encased or in a ductbank, conduit spacers, and cradles shall be installed on a bed of compacted CA-6 gravel. Refer to conduit section for backfilling and ductbank requirements.

9. Backfill with sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.

10. Place all backfill above the sand in uniform layers not exceeding 6” deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.

11. 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 as 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 as determined by AASHTO T-99 or ASTM D-698 test.

12. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

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 and landscaping features removed or damaged to its original condition. At least 6” of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.

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. Broken edges shall be saw cut and repaired as directed by Architect/Engineer.

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 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.

3.4 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 shall 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. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

3. 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.

4. 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 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.

3.5 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.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. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, _____ paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.

2. Binder Requirements: The Contractor shall submit three sets of O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2"12mm thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.

3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.

4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. 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.

3.6 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 each item and/or system shall be as indicated in each individual specification section.

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.

3.7 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.

3.8 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. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.

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.

E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish 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. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Architect.

G. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.

H. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.

2. Plastic Surfaces - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

I. In accordance with LEED EQc4.2: Low-Emitting Materials - Paints and Coatings, all paints and coatings used on the interior of the building must comply with the following criteria:

1. Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.

2. Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L (2 lb./gal) established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

3.9 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.

3.10 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.

D. 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 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.

3.12 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. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)

2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain. Ground resistance values shall be verified by the Architect/Engineer at the time the readings are taken.

3. If the ground resistance value obtained is more than the value set forth in Section 26 05 26, the following shall be done to obtain the value given:

a. Verify that all connections in the service ground system are secure.

b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.

c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.

d. Review results with the Architect/Engineer.

4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:

a. Date of test.

b. Number of hours since the last rain.

c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.

d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.

e. Make, model, and calibration date of test equipment.

f. Tabulation of measurements taken and calculations made.

C. 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.

D. 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.

3.13 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 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, 75% of the construction and demolition debris for this project must be recycled or salvaged.

END OF SECTION 26 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 of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Smoke and fire/smoke dampers are wired and have been tested.
4. Per Section 26 05 00, cable insulation test results have been submitted.
5. Per Section 26 05 00, medium voltage testing report has been submitted.
6. Per Section 26 05 00, ground resistance test results have been submitted.
7. Operation and Maintenance manuals have been submitted as per Section 26 05 00.
8. Bound copies of approved shop drawings have been submitted as per Section 26 05 00.
9. Report of instruction of Owner's representative has been submitted as per Section 26 05 00.
10. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
11. Start-up reports from factory representative have been submitted as per Section 26 05 00.

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.

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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. The Building Officials and Code Administrators National Building Code
H. 2006 International Building Code
I. 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

Penetrating Item	UL System No.
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
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999

Penetrating Item	UL System No.
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

Penetrating Item	UL System No.
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
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

Penetrating Item	UL System No.
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
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 13 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building wire
B. 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 854 – Service-Entrance Cables

E. 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.

B. Feeders and Branch Circuits Larger than 6 AWG in Underground Conduit: Copper, stranded conductor, 600 volt insulation, THWN.

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 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 60ºC, 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 AND CABLE INSTALLATION SCHEDULE

A. Above Accessible Ceilings: Building wire in raceways.

B. All Other Locations: Building wire in raceway.

C. Above Grade: All conductors installed above grade shall be type “THHN”.

D. Underground or In Slab: All conductors shall be type “THWN”.

3.2 WIRE FOR SPECIALIZED SYSTEMS

A. Wire for the following 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:

1. Fire alarm
2. Low voltage switching
3. Sound
4. Data
5. Clock

3.3 CONTRACTOR CHANGES

A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16. Service entrance conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.310.15(B)(2)(7).

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. Underground electrical duct ampacity rating shall be in accordance with NEC Table B.310.15(B)(2)(7) or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.

D. Record drawing shall include the calculations and sketches.

3.4 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. Use no wire smaller than 8 AWG for outdoor lighting circuits.

E. 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.

F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.

G. Splice only in junction or outlet boxes.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

I. Make conductor lengths for parallel circuits equal.

J. All conductors shall be continuous in conduit from last outlet to their termination.

K. Terminate all spare conductors on terminal blocks, and label the spare conductors.

L. Cables or wires shall not be laid out on the ground before pulling.

M. Cables or wires shall not be dragged over earth or paving.

N. 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.

O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.

P. 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.

3.5 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).

3.6 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.

3.7 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.

END OF SECTION 26 05 13

SECTION 26 05 15 - MEDIUM-VOLTAGE CABLE AND ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Medium voltage power cable
B. Cable terminations

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in medium voltage cable and accessories with minimum five (5) years documented experience.

B. Installer: The installing Company shall employ personnel with a minimum of five (5) years documented experience in medium voltage cable installation. Resumes shall be submitted documenting the experience of all personnel pulling, splicing, terminating and testing the medium voltage cable.

1.3 REFERENCES

A. AEIC CS8 (Association of Edison Illuminating Companies) - Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 KV

B. ANSI/IEEE C2 - National Electrical Safety Code

C. ICEA S-93-639 (Insulated Cable Engineers Association) / NEMA WC74 - 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

D. ICEA S-94-649 - Standard for Concentric Neutral Cables Rated 5 Through 46 KV

E. ICEA S-97-682 - Standard for Utility Shielded Power Cables Rated 5 Through 46 KV

F. IEEE 48 – Standard for Test Procedures and Requirements Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV

G. IEEE 386 – Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

H. International Electrical Testing Association – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (refer to the medium voltage cable DC testing requirements)

I. NFPA 70 - National Electric Code

J. UL 1072 - Standard for Medium-Voltage Power Cables

1.4 SUBMITTALS

A. Submit product data under the provisions of Section 26 05 00.

B. Submit product data indicating cable and accessory construction, materials, and ratings.

C. Submit manufacturer's installation instructions under provisions of Section 26 05 00.

D. Submit manufacturer's statement that medium voltage cable meets or exceeds specified requirements.

E. Submit contractor qualification resumes documenting requirement specified in QUALITY ASSURANCE heading of this specification section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 05 00.

B. Store and protect products under provisions of Section 26 05 00.

C. Accept cable and accessories on site in manufacturer's packages and inspect for damage.

D. Protect cable and accessories from weather by covering with opaque plastic or canvas; provide ventilation to prevent condensation.

1.6 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Section 26 05 00.

B. Accurately record exact sizes and locations of cables.

1.7 REGULATORY REQUIREMENTS

A. Conform to ANSI/IEEE C2 and NFPA 70.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cable product supplied shall be stated by its manufacturer to be suitable for the application for which it will be installed and used, as indicated on project drawings. This includes, but is not limited to, the following applications as permitted by the National Electric Code.

1. Use indoors and/or outdoors.

2. Installation in wet and/or dry locations.

3. Use in conduits and duct banks. Where installed in conduits or underground ducts, the cable manufacturer’s product supplied shall be suitable for the conduit sizes specified on the project drawings. Where a manufacturer’s cable size is recommended by a given manufacturer to be installed in a larger conduit or underground duct and other acceptable manufacturers’ cables are available and the other acceptable manufacturers allow installation of their cables within the drawing conduit sizes and underground duct sizes, cables that work with the conduit sizes and underground duct sizes shown on project drawings shall be supplied.

4. Direct buried installations of cable.

5. Messenger-supported aerial installations in industrial facilities.

B. The Okonite Company
C. Southwire
D. Prysmian (USA)
E. General Cable
F. The Kerite Company
G. Aetna Insulated Wire

2.2 MEDIUM VOLTAGE POWER CABLE

A. Cable: Insulated, shielded cable rated 15 KV.

B. NEC medium voltage, solid dielectric “Type Letter” shall be MV-105.

C. “Single” or “multi-conductor” cables shall be supplied as indicated on project drawings. Multi-conductor cables shall include full size ground conductors.

D. Conductors shall be copper compact stranded or compressed stranded.

E. The cable shall have a semi-conducting shield layer between the metal conductor and insulation layer as a strand screen.

F. Insulation: Ethylene-propylene rubber (EPR), 133% insulation level. 15 KV rated cable shall have a minimum of 175 mils of insulation for 100 percent insulated cable and a minimum of 220 mils for 133 percent insulated cable.

G. The cable shall have a semi-conducting shield layer over the insulation. The cable shall have a helically applied copper tape metallic shield over previously described layers. The tape shield shall be minimum of 5 mils thick with a 25 percent overlap.

H. The cable shall have an overall outer moisture and sunlight resistant PVC jacket.

2.3 ACCEPTABLE MANUFACTURERS - CABLE TERMINATIONS

A. 3M Company
B. Tyco Electronics (Raychem)
C. Elastimold
D. Cooper

2.4 CABLE TERMINATIONS

A. Medium voltage cable termination types shall be provided as specified on the project drawings and listed in this specification. If no specific type of termination is specified on the drawings, a cable termination type suitable for the equipment or device to which the medium voltage cable is being terminated may be selected from the types described in this specification, given the suitable type is acceptable per the equipment or device manufacturer to which the cable is being terminated. The supplied termination shall be rated for the indoor or outdoor location in which it is being installed and applied. The supplied termination shall also be rated by its manufacturer for the exact type and size of cable to which the termination shall be applied.

B. Cold Shrink Terminations: Termination kits shall meet the requirements of IEEE Standard 48 for Class 1 terminations. Termination shall be installed per the manufacturer’s instructions by certified installers who have received authorized training from the manufacturer. Terminations installed on type MC armored cable shall include rejacketing materials to cover any exposed cable shield from the point where the outer MC armor sheath terminates to where the medium voltage termination kit is applied.

C. 200 Amp Loadbreak Cable Connectors: IEEE 386 type termination. Cable termination loadbreak elbow connectors, one per each single conductor phase cable. Connectors rated at 200 amps and, as a minimum, rated for the voltage class of the cable and equipment/devices to which the cable is connected. 15 KV rated terminations may be shown and required for 5KV equipment applications. 25 KV rated terminations may be shown and required for 15 KV equipment applications. The loadbreak elbow shall be installed per the manufacturer's instructions. The loadbreak elbow shall work with a corresponding 200-amp loadbreak, IEEE 386 type bushing insert that has been factory supplied and installed. The equipment bushing inserts shall be provided as part of the cable terminations and field installed on the equipment/device if not factory furnished.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conduit, duct banks, cable trays, trenches, or other raceways, as may be applicable to the project, are ready for cable installation.

B. Beginning of installation means installer accepts existing conditions.

3.2 PREPARATION

A. Thoroughly swab conduits to remove foreign material before pulling cables.

3.3 INSTALLATION

A. Install cable and terminations in accordance with manufacturer's instructions and to ANSI/IEEE C2.

B. Ground cable shield at each termination and splice with a shield adapter kit consisting of braided ground lead and a shrink tube cover.

C. Pull cables using suitable water-based lubricants and cable pulling equipment. Do not exceed cable pulling tensions and bending radius recommended by manufacturer.

D. Install cable in manholes along those walls providing the longest route and most spare cable lengths. Arrange cable to avoid interferences with duct entrances into manhole.

E. Avoid abrasion and other damage to cables during installation.

F. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping extended one inch into ducts.

G. Loop cables around manhole where terminations are not required.

H. Medium voltage cables shall be continuous between junction boxes, pull boxes, manholes, or equipment terminal cabinets. No splices will be permitted in medium voltage cables except at junction boxes, pull boxes, manholes, or equipment terminal cabinets.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 05 00.

B. Inspect exposed cable sections for physical damage. Verify that cable is connected according to drawings and that shield grounding, cable support, and terminations are properly installed.

C. Contractor shall inform Architect/Engineer of testing schedule to be performed one week prior to commencing testing should they want to witness testing.

D. Cable Testing: The Contractor shall verify this test procedure with the cable manufacturer and the cable termination manufacturers to receive their approval for conducting the following tests. The Contractor shall insure that the maximum test voltage does not exceed the limits for terminators specified in ANSI/IEEE48, IEEE 386, or manufacturer's specifications. The medium voltage cable testing shall be performed in accordance with the International Electrical Testing Association (NETA) Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, specifically the sections relevant to direct voltage cable testing of medium voltage cable, plus the information contained in this specification. Performance of the test by the Contractor shall constitute acceptance has been received and approved.

1. Test of high voltage cable over 600V shall be made in the presence of the Architect/Engineer or the Owner's designated representative.

2. High voltage cable installed in conduit, direct burial or metal jacketed type power cable over 600V shall be given continuity and a direct current high potential test after installation and terminations have been made, but before connections have been made to busses or apparatus. All single conductor cables shall be tested between conductors and ground with metallic shield and the other two conductors grounded to the same ground. Each conductor shall be successively tested in the same manner. Direct current voltages shall be applied with negative polarity to the cable conductor.

3. Record and plot the test data on the form found at the end of this section including all information requested.

4. Tests shall be made immediately after installation, but prior to putting the cables into final service. This is commonly referred to as an Acceptance Test.

5. This Contractor shall employ an independent testing service that specializes in DC Hypot Cable Testing to certify accuracy of all data submitted. This Contractor shall submit the name of the testing service being employed along with the proposal form when bidding the project.

6. All test data and graphs shall be submitted to the Architect/Engineer. Graphs shall be evaluated by the Architect/Engineer. If data and graphs are not acceptable, the Contractor shall be responsible for replacing the cable or reworking terminations, etc., at his expense until satisfactory test results are obtained.

7. The Architect/Engineer and cable manufacturer shall both be notified ten (10) days in advance of testing date so that either or both can have representatives present to witness the testing.

8. Final acceptance of the cable will depend upon satisfactory results of the High Potential Test. If a second test is necessary, it shall similarly withstand a reduced voltage (60% to 70% of the first field test voltage). Retest only upon instructions received from the Owner.

9. No cable shall be permanently energized until the master copy of its test record is approved by the Architect/Engineer. Three copies of the test report shall be furnished to the Owner and one copy furnished to the Architect/Engineer.

10. The Contractor shall provide all required electrical power to operate any test equipment. The power can be obtained from an existing power source (if acceptable by the Owner) or by use of a portable generator provided by the Contractor.

11. Preparatory Steps:

    a. Adequate safety precautions shall be taken so personnel and equipment will not come in contact with the cable ends while testing.

    b. Disconnect both ends of the cable and make free of all equipment.

    c. Each cable shall be given a continuity test and shall be identified with a phase designation.

    d. Seal cables to prevent corona from forming at the end opposite of where the testing equipment is to be connected. Seal cables as follows:

        1) On the free end of cable that is to be tested, wrap all metal parts of terminator with 3M #23 tape 1/2 wrap, a total of 4 complete wraps. Cover with a clear plastic bag and tape off bag end.

        2) On the testing end of cable, connect the high connector to cable termination. Wrap all metal parts of terminator, including high pot connection, with 3M #23 tape 1/2 wrap, a total of 4 complete wraps. Cover with a clear plastic bag and tape off bag end.

    e. On shielded cables, ground all shields to the same point.

    f. Cables not being tested shall be grounded to the same point as the shields.

    g. Set up and connect the "Hi-Pot" tester as recommended by the manufacturer.

    h. Make final safety and grounding test.

12. Testing Procedures:

    a. Record the wet-bulb and dry-bulb temperatures or relative humidity and temperature of the test site conditions.

    b. Test each cable section individually.

    c. Test each conductor individually with all other conductors grounded. Ground all shields as stated in the Preparatory Steps.

    d. Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable method such as taping and bagging, as necessary.

    e. Test Voltages for 5KV to 15KV Cable: For new cable in its first field test, raise the conductor to **THE LOWEST** of the maximum test voltages and

times specified by the cable manufacturer, the termination manufacturer, or the NETA "Medium-Voltage Cables Acceptance Test Values" for "DC Test Voltages". The values in the following table should agree with the NETA values. **Older cables or cables undergoing repeat testing shall be tested only to the voltage levels recommended by the cable manufacturer and agreed to by the Owner.** It is recommended that the test of older cable not exceed 60-percent of the factory test value of new cable.

TABLE OF MAXIMUM DC TEST VOLTAGES OF NEW CABLE					
Cable test voltages may need to be less due to cable termination device limitations or lower cable manufacturer specified limits.					
		Nominal Insulation Thickness mils		**Maximum DC Field Test Voltages, KV During/After Installation**	
Rated Voltage Phase-to Phase KV	**Conductor Size AWG or kcmil**	**100% Insulation Level**	**133% Insulation Level**	**100% Insulation Level**	**133% Insulation Level**
5	8 – 1000	90	115	28	36
5	Above 1000	140	140	28	36
8	6 - 1000	115	140	36	44
8	Above 1000	175	175	36	44
15	2 - 1000	175	220	56	64
15	Above 1000	220	220	56	64

f. Apply test voltage in not less than 5 equal steps, with a maximum of 5KV per step for adequate charting. Raise the conductor to the specified maximum test voltage and hold for NO LONGER THAN 15 MINUTES AT THE MAXIMUM TEST VOLTAGE. A stable leakage current at the maximum test voltage for 10 minutes duration shall be considered an adequate test.

g. Raise the test voltage to the first step slowly and observe the current reading. There will normally be an initial charging current, which should drop to a constant stable condition. Note the time for current stabilization. This will normally be about the same for each step.

h. If there is ground or short on the system, an immediate high current reading will be indicated and possibly the overload relay of the test unit will open.

i. After the reading has stabilized, record the reading on the test form and chart. Plot the curve as data is obtained. Note what is and is not acceptable. If readings and curve indicate a non-acceptable test, discontinue any further testing before a breakdown occurs.

j. Repeat the previous steps of raising the voltage and recording/plotting data for each voltage step up to the maximum test voltage.

k. After the maximum test voltage has been reached, leave the maximum voltage on for 10 minutes. Record and plot current readings at the ends of the following intervals: 15 seconds, 30 seconds, 1 minute, 2 minutes, and each minute to 10 minutes. Typical interpretation curves can be provided to the Contractor by the Architect/Engineer.

l. Remove the test voltage and allow the voltage on the cable to decay. Record voltage value after 10 seconds and again after 30 seconds and 60 seconds. Ground the cable and remove the HV test lead.

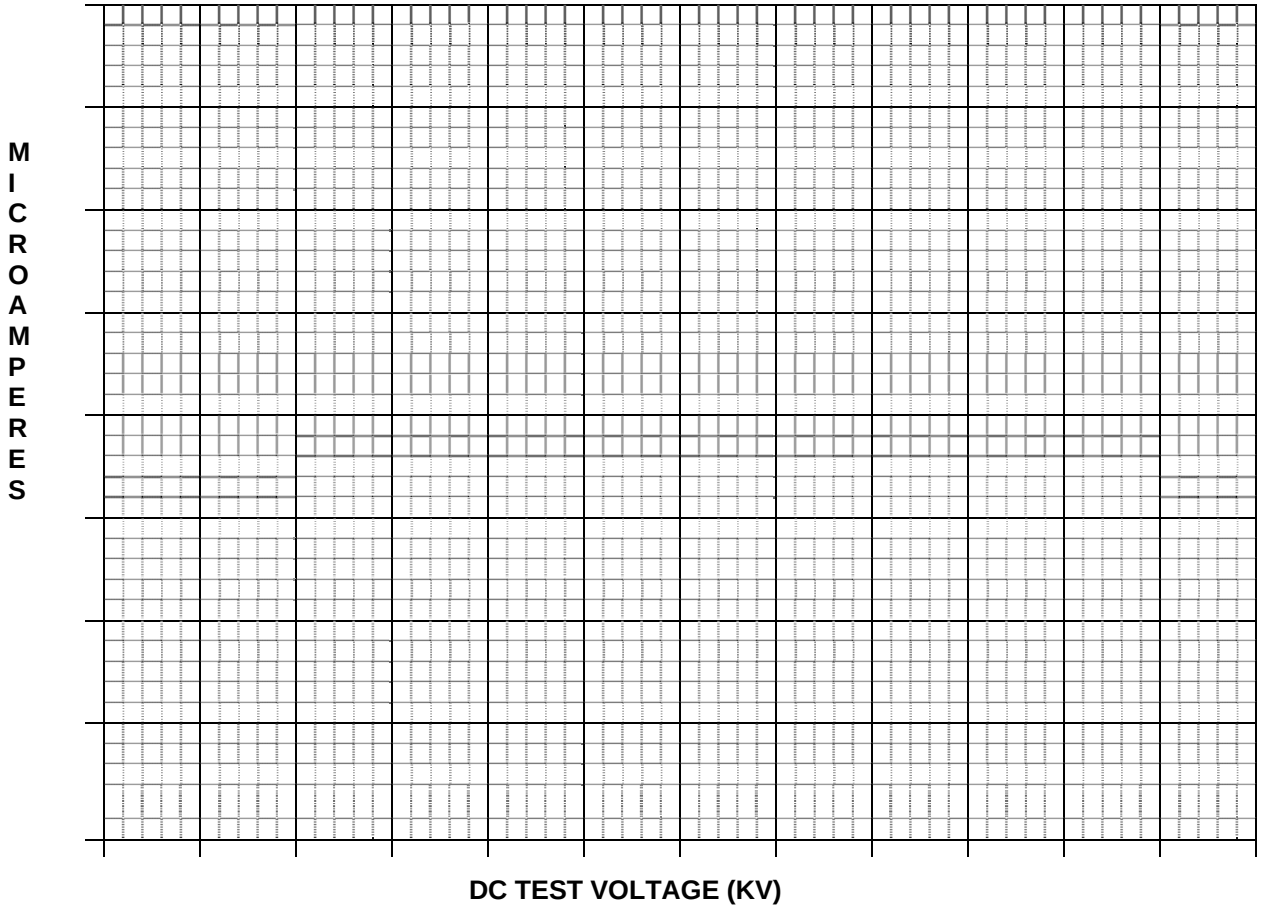
1) Do not ground the cable until the voltage has been reduced to less than 3000V.

m. Repeat the procedure for the other cables.

END OF SECTION 26 05 15

JOB LOCATION				DATE	
CIRCUIT NO.		PHASE		WIRE SIZE	
CABLE MFG'R		RATING		INSULATION TYPE	
AMBIENT TEMPERATURE		HUMIDITY		VOLTAGE INCREMENTS	STABILIZATION TIME
TYPE OF TEST					
OPERATOR				WITNESS	

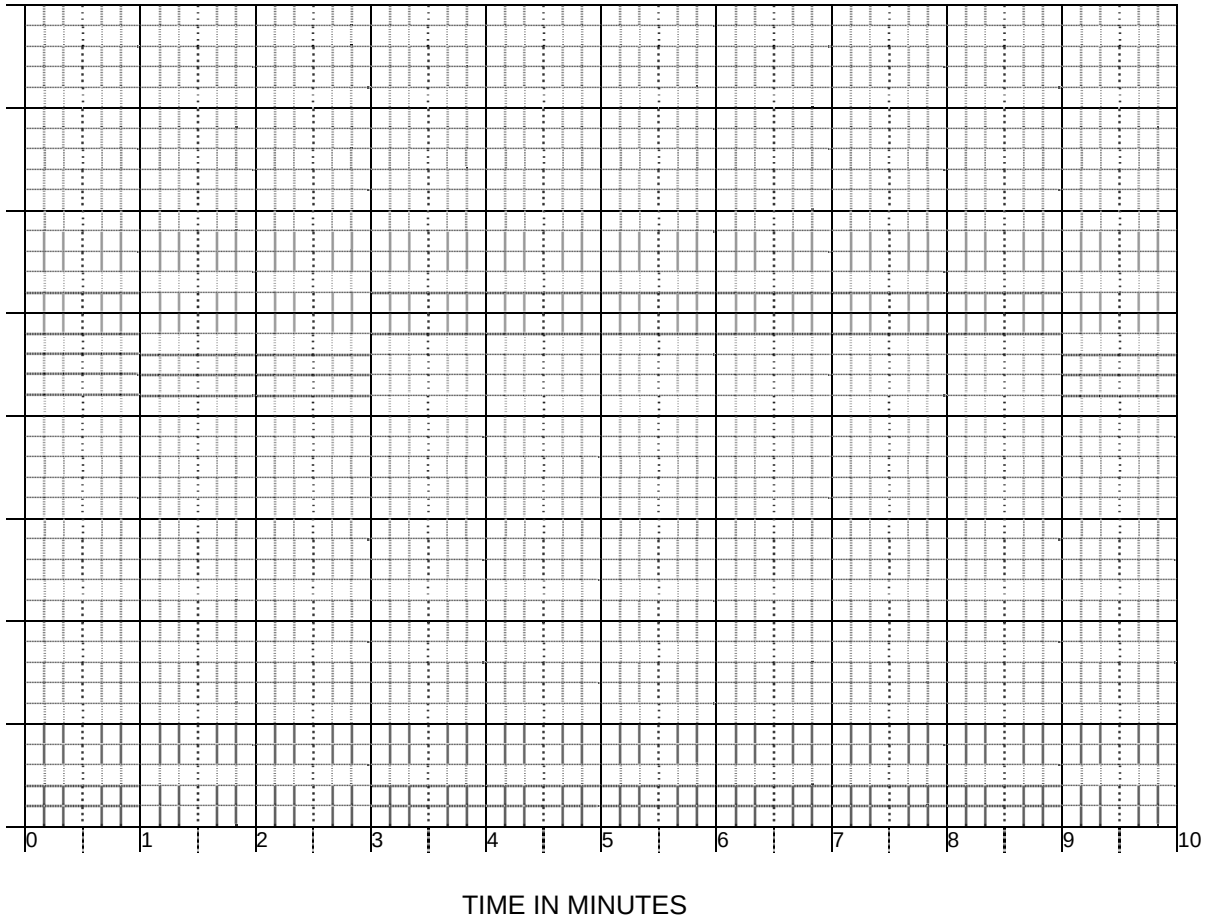
MICROAMPERES vs DC TEST VOLTAGE (KV)



kV	MICROAMPERES

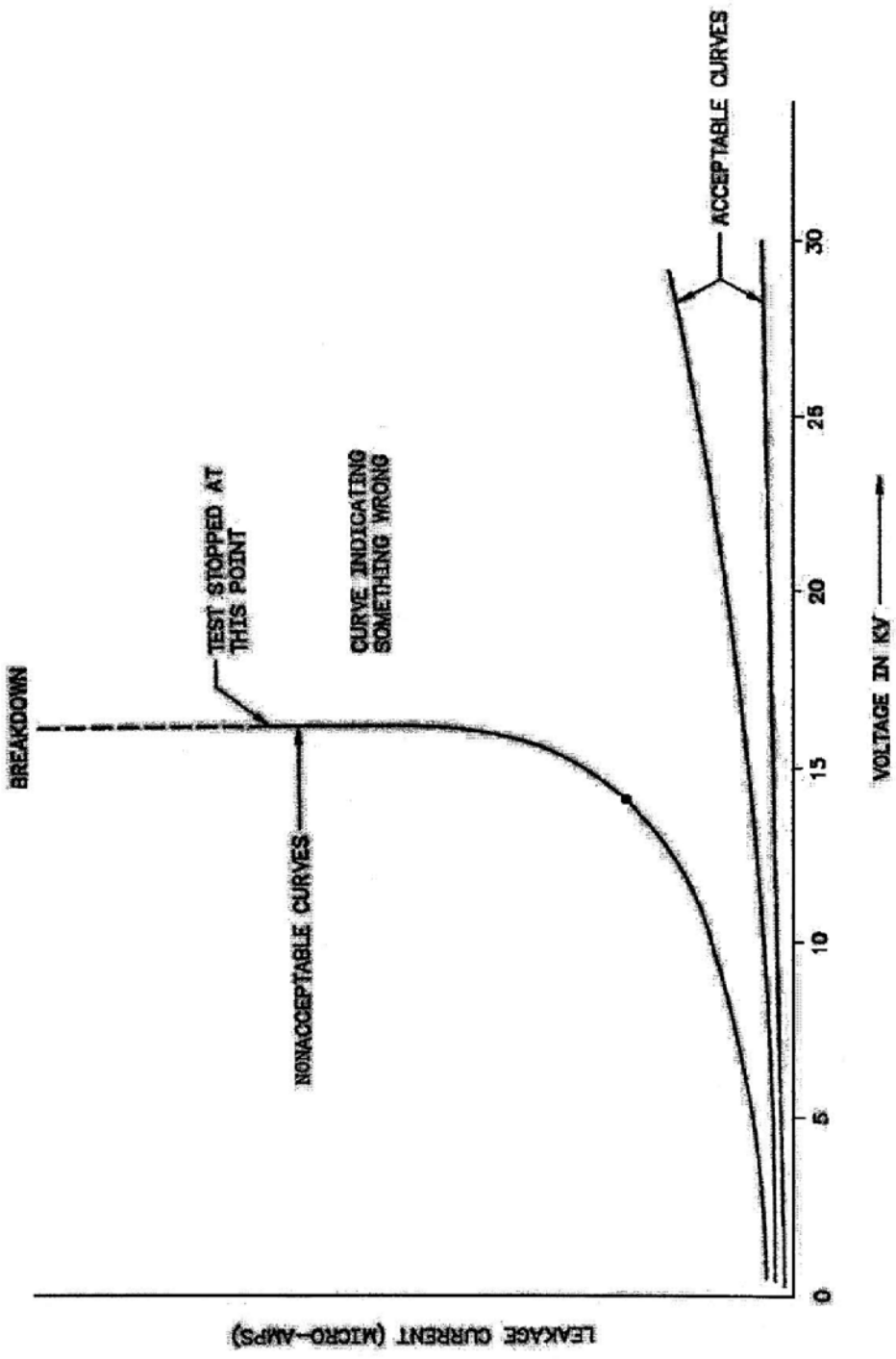
JOB LOCATION				DATE	
CIRCUIT NO.		PHASE		WIRE SIZE	
CABLE MFG'R		RATING		INSULATION TYPE	
10 SECOND		30 SEC.		60 SECOND	kV
TYPE OF TEST					
OPERATOR				WITNESS	

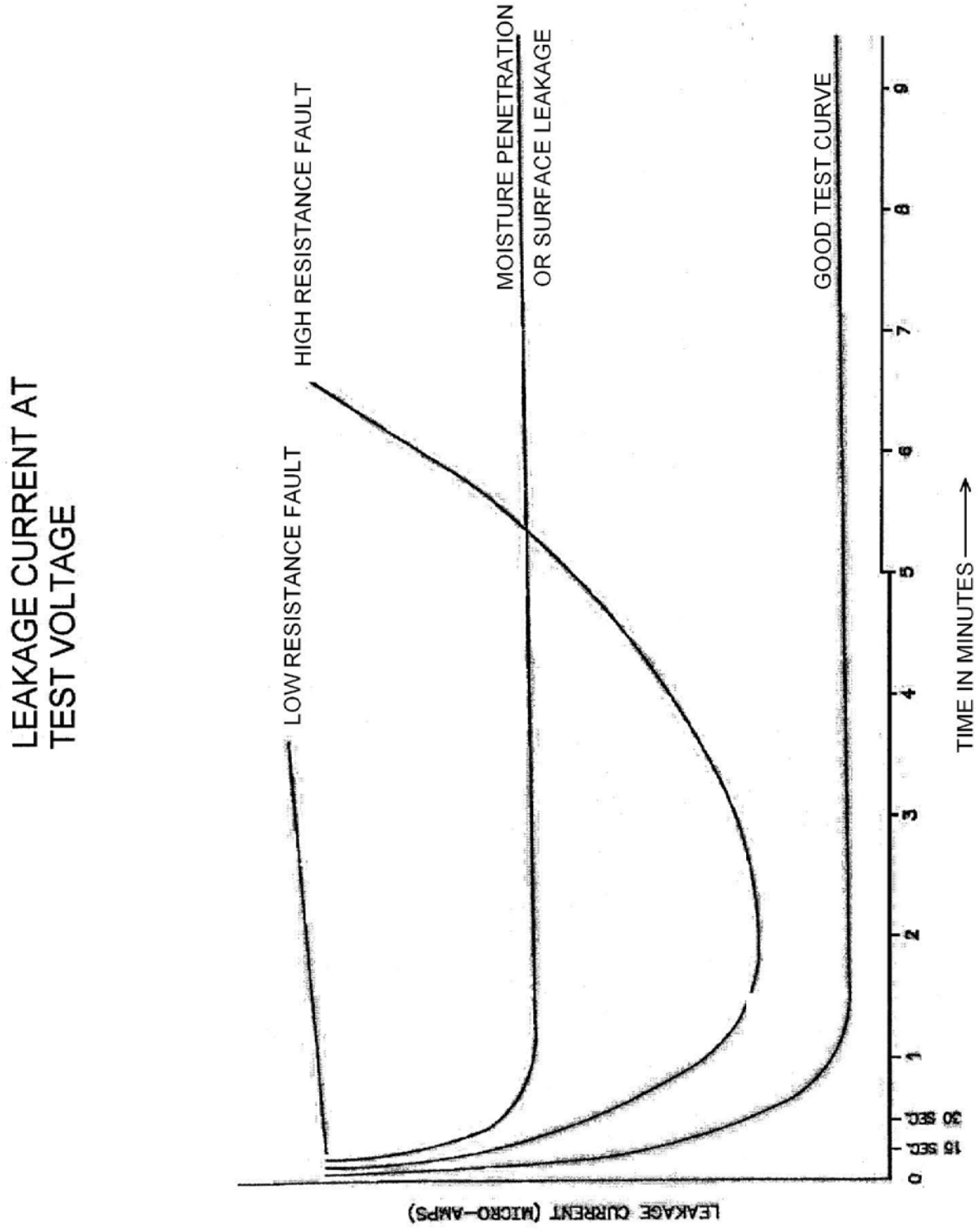
LEAKAGE CURRENT vs TIME @ TEST VOLTAGE



TIME	MICROAMPERES
15 SEC	
30 SEC	
1 MIN	
2	
3	
4	
5	
6	
7	
8	
9	
10 MIN.	

LEAKAGE CURRENT AT
INCREASING VOLTAGE




LEAKAGE CURRENT AT
TEST VOLTAGE
LOW RESISTANCE FAULT
HIGH RESISTANCE FAULT
MOISTURE PENETRATION
OR SURFACE LEAKAGE
GOOD TEST CURVE
LEAKAGE CURRENT (MICRO-AMPS)
TIME IN MINUTES
0
15 SEC.
30 SEC.
1
2
3
4
5
6
7
8
9

SECTION 26 05 26 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment grounding system
B. Grounding electrode system

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

B. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

C. 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.

D. Comply with UL 467 Grounding and Bonding Equipment.

E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

F. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE/ANSI C2 National Electrical Safety Code (NESC).

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. Sizes and types below are typical. Adjust to suit Project conditions and requirements.

G. 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.

H. **[IBT]:** Intersystem Bonding Termination:

1. Copper bar, 1/4" x 2" x 2". Provide with wall mounting brackets, insulators and pre-tapped holes.

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: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

C. Bolted Connectors: Bolted-pressure-type connectors.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Sectional type; copper-clad steel.

1. Size: 3/4" in diameter by 120 inches per section.

B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

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. Underground Connections: Exothermic-welded connections. Use for underground connections, except those at test wells.

H. Connections at Test Wells: Use compression-type connectors on conductors and make two bolted- and clamped-type connections between conductors and ground rods.

I. 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.

J. 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. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.

D. 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.

E. In raceways, use insulated equipment grounding conductors.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

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.

3.4 GROUNDING ELECTRODE SYSTEM

A. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.

B. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

C. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or 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.

D. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

E. Bond each aboveground portion of natural gas metallic piping system at equipment locations. The equipment grounding conductor may serve as the bonding means.

3.5 EQUIPOTENTIAL (MULTI-POINT) GROUNDING SYSTEM

A. Provide an equipotential grounding system in the following locations:

1. Hydrotherapy tub as required in NEC 680

B. The non-current-carrying metal parts of equipment, raceways and other enclosures shall be bonded to the grounding system.

3.6 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation. The pad rebar shall be attached to the counterpoise conductor at the four corners.

3.7 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.

2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:

3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

4. Testing: Perform the following field quality-control testing:

a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance 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.

c. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

1) Equipment Rated 500 kVA and Less: 10 ohms.
2) Equipment Rated 500 to 1000 kVA: 5 ohms.
3) Equipment Rated More Than 1000 kVA: 3 ohms.
4) Substations and Pad-Mounted Switching Equipment: 5 ohms.
5) Manhole Grounds: 10 ohms.

d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

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. High density polyethylene conduit and fittings
H. Wall and ceiling outlet boxes
I. Electrical connection
J. Pull and junction boxes
K. Floor boxes
L. 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
6. ANSI/NEMA OS 2 - Nonmetallic 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. UL651-B – Continuous Length HDPE Conduit
7. UL746A – Standard for Polymeric Materials – Short Term Property Evaluations
8. UL797 – Electrical Metal Tubing
9. UL1242 – Intermediate Metal Conduit

G. American Standard of Testing and Materials (ASTM):

1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material

H. 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.

1.3 SUBMITTALS

A. Provide product submittals to the Architect/Engineer, per specifications, on floor boxes and floor box accessories.

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 with #14 AWG THHN conductors and an insulated ground wire.

B. Acceptable Manufacturers: American Flex, Alflex, 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, Alflex, 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 HIGH DENSITY POLYETHYLENE

A. Minimum Size: 2 inch, unless noted otherwise.

B. Acceptable Manufacturers: Carlon, Chevron Phillips Chemical Company, or approved equal.

C. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	< .941
D-1238	Melt Index, g/10 min Condition E	> .55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.

ASTM Test	Description	Values HDPE
D-790	Flexural Modulus, MPa (psi)	< 80,000
D-746	Brittleness Temperature	-75°C Max

D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.

E. Fitting and Conduit Bodies:

1. Directional Bore and Plow Type Installation: Electrofusion or Universal Aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.

2. For all other type of installation: Coupler must provide a water tight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.

3. E-loc type couplings are not acceptable in any situations.

4. Acceptable Manufacturers: ARCON, Carlon, or approved equal.

2.8 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 feralloy, 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. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch 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.

2.9 **[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.

2.10 **[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. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.

E. Flanged type boxes shall be used where installed flush in wall.

2.11 FLOOR BOXES

A. Color: Verify with Architect.

B. Coordinate with Technology drawings for voice/data outlet requirements.

C. Floor Boxes for Installation in Cast-In-Place Concrete Floors: Fully adjustable, cast iron.

D. **[FB-1]**: Flush-mounted, round, cast iron floor box with NEMA 5-20R duplex receptacle. 125 volt, 20 amp, industrial specification grade, straight blade, 3-wire grounding type with impact resistant thermoplastic face. Fully adjustable, round brass cover with duplex flap cover and brass carpet flange.

1. Approved Manufacturers:

a. Hubbell B2537 (Box), S3925 (Cover), S3082 (Flange), HBL5362 (Recept)
b. Walker 889
c. Steel City 602-SC / P60-DS

E. **[FB-2]**: Cast iron floor box, dual compartment, flush mount, brass carpet flange. One compartment with one (1) duplex NEMA 5-20R receptacle and brass duplex flap cover. One compartment with brass 2-1/8" x 3/4" combination cover and one (1) 3/4" conduit stubbed to above the lay-in ceiling.

1. Approved Manufacturers:

a. Hubbell B4233 (Box), S2425 (Cover), S3825 (Cover), SB3084 (Flange), 5362 (Recept)
b. Walker 880CS2
c. Steel City 642

F. **[FB-3]**: Three service floor box - tele/power/data. Equivalent mounting space of four (4) single gang boxes consisting of one (1) 20 amp, 125 volt, NEMA 5-20R duplex receptacle, one (1) voice outlet, one (1) data outlet, and one (1) spare. Steel adjustable rectangular floor box with flush cover.

1. Approved Manufacturers:

a. Walker RFB4
b. Steel City 665
c. Hubbell HBLCFB301BASE

2.12 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 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 would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)

2. Below Grade 5' or less from Building Foundation: 1 inch.

3. Below Grade More than 5' from Building Foundation: 1 inch.

4. Telecommunication Conduit: 1 inch.

5. Controls Conduit: 3/4 inch.

C. Maximum Conduit Size Embedded in Slabs above Grade: 3/4 inch for conduits crossing each other.

D. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.2 CONDUIT ARRANGEMENT

A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. 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.

3.3 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 1-1/2" 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.

3.4 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 <u>not</u> 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. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3” min. concrete cover. Conduits shall run parallel to each other and spaced at least 8” apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1”.

10. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.

11. Do not route conduits across each other in slabs on grade.

12. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.

13. 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.

14. 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.

15. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.

16. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3” above finished floor (AFF).

17. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4” below ceiling and as close to the wall as possible.

18. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4” above finished floor (AFF) and as close to the wall as possible.

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

3.6 UNDERGROUND CONDUIT INSTALLATION

A. Conduit Connections:

1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

B. Conduit Bends (Lateral):

1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.

2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2” and ten times the diameter for conduits over 2”. Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.

C. Conduit Elbows (vertical):

1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (>600V) and 18 inches for secondary conduits (<600V). Increase radius, as required, based on pulling tension calculation requirements.

D. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.

2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.

3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum f'c = 2500 and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.

4. Before the Contractor pulls any cables into the conduit he shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.

5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.

6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.

7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.

8. All non-metallic conduit installed underground outside of a slab shall be rigid.

E. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.

2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

F. Raceway Seal:

1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.

2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with “JackMoon” or equivalent duct seal, capable of withstanding a 10 foot head of water (5 PSI).

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. Exposed:

a. Switchboards, panel feeders, etc.: EMT.

b. Branch Circuits (lighting, receptacles, controls, etc.): EMT.

c. Mechanical Equipment Feeders (pumps, AHU's, chillers, etc.): EMT.

d. Floor Mounted Pump Feeders: EMT with no more than 6’ of PVC coated flexible metal conduit to pump.

e. Controls: MT painted blue or dyed blue.

2. Finished Spaces/Concealed: EMT.

3. Wet or Damp Locations: RMC conduit, boxes and fittings, installed and equipped so as to prevent water from entering the conduit system.

4. In Slabs Above Grade: Embedded RMC.

5. In or Under Slabs on Grade or Site Conduits:

a. Within 5' from the Exterior Perimeter of a Building Foundation: RMC conduit with a minimum of 3" thickness between the surface of the concrete and the nearest conduit. Concrete to be doweled into the foundation.

b. 5' or Greater from the Exterior Perimeter of a Building Foundation: PVC.

c. Under Roads, Drives, and Vehicle Traveled Ways: Concrete encased PVC with a minimum of 3” concrete cover on all sides of conduit.

d. Reinforcing shall consist of one-half inch deformed bars spaced 12 inches on center, paralleling the ducts on bottom, with one-half inch deformed tie bars spaced twelve inches on centers.

e. Bars shall overlap forty (40) diameters and shall extend 5' beyond roads, drives, traveled ways, etc.

f. Provide minimum 3" concrete cover on all sides of reinforcing.

g. Entire ductbank shall be installed on precast concrete pavers on 3’ centers.

6. Interior Locations:

a. Exposed: EMT conduit.

1) Exposed Controls Conduit: EMT painted blue or dyed blue.

b. Concealed: EMT.

7. Hazardous Locations as Defined by the National Electrical Code: RMC conduit complete with screwed fittings and conduit seals.

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 stud wall of laundries and concession.

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. Concession and laundries when exposed on wall surface.

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 floor 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, 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 FLOOR BOX INSTALLATION

A. Set boxes level and flush with finish flooring material.

B. Use cast iron floor boxes for installations in slab on grade. Trim shall match floor covering to be used.

C. Provide a minimum horizontal offset of 24 inches between boxes.

D. Provide saw-cutting and patching of existing concrete floors as necessary for floor box installations within existing floors.

3.12 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, 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.

3.13 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 35 - SURFACE RACEWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Surface metal raceways

1.2 REFERENCES

A. FS W-C-582 - Conduit, Raceway, Metal, and Fitting; Surface

PART 2 - PRODUCTS

2.1 SURFACE METAL RACEWAY

A. Surface Metal Raceway: FS W-C-582; sheet metal channel with fitted cover, suitable for use as a continuous surface metal raceway.

B. Finish: Coordinate paint color with Architect.

C. Fittings: Couplings, elbows, and connectors designed for use with raceway system.

D. Boxes and Extension Rings: Designed for use with raceway systems.

E. Coverplates shall be same material and finish as raceway.

F. Normal power receptacles shall be same color as raceway.

G. Receptacles and outlets shown on raceway on drawings shall be mounted with overlapping faceplates in the raceway and shall not be mounted in boxes unless specifically noted otherwise.

H. **[WW-1]:** Surface metal raceway, metallic cover, minimum 4" opening, power / communication divider, minimum 7.5 square inch capacity.

1. Approved Manufacturers: Wiremold G4000/G4048, Mono-Systems SMS4200, Hubbell HBL4750 Series.

I. **[WW-2]:** Over floor power raceway, low profile.

1. Approved Manufacturers: Wiremold OFR.

PART 3 - EXECUTION

3.1 INSTALLATION - SURFACE METAL RACEWAY AND MULTI-OUTLET ASSEMBLY

A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Maintain grounding continuity between raceway components to provide a continuous grounding path.

D. Fastener: Use clips and straps suitable for the purpose.

E. Field cuts to be clean and straight and use the proper tools as recommended by the system manufacturer to prohibit damage to factory finish or raceway. Joints to be matched so there are no gaps or spaces in the cover. Furnish and install manufacturer's raceway accessories as needed.

F. Provide conduits to technology raceway per drawings or provide a minimum of one (1) 1-1/4" conduit per six feet of assembly (minimum 2) to above ceiling for technology requirements if assembly has technology raceway (Contractor shall provide quantities of conduits that provide maximum capacity to assembly). Provide conduits equally spaced within entire length of assembly.

G. Provide one (1) 3/4" empty conduit per six feet of assembly (minimum 1) to above ceiling for future power needs. Provide conduits equally spaced within entire length of assembly.

END OF SECTION 26 05 35

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 color coding
D. Conductor color coding
E. Power distribution equipment labeling
F. Transformer equipment labeling
G. Pole identification

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 ¼" 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 ¼" 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 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. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system voltage and contained circuit on outside of box cover. Labeling shall be 3/8-inch Kroy tape or Brother self-laminating vinyl label, color-coded same as conduits or permanent magic marker (color coded), neatly hand printed. All fire alarm boxes shall have covers painted red.

E. 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.

F. Apply warning, caution and instruction signs as follows:

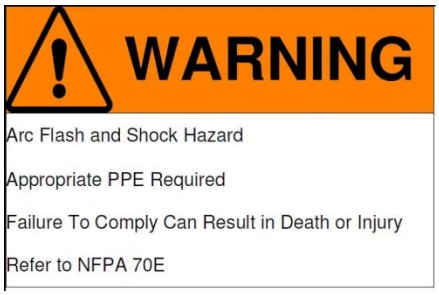
1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where 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.

G. 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.

H. 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.

I. Install ARC FLASH WARNING signs on all switchboards, panelboards, industrial control panels, and motor control centers. Sign at a minimum shall contain:



J. Circuits with more than 600V: Identify raceway and cable with "DANGER—HIGH VOLTAGE" in black letters 2 inches high on orange background at 10'-0 foot intervals.

1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.

2. Wall surfaces directly external to conduits concealed within wall.

3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single marker. Limit line markers to direct-buried cables. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

3.2 RECEPTACLE COVER PLATES

A. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (i.e. “PL1A #33”).

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. Permanently affix identification label to cover plates, centered above the receptacle openings.

3.3 EQUIPMENT CONNECTION IDENTIFICATION

A. Provide identification on all electrical connections to equipment that do not include control equipment described in the paragraph below. Identification shall be provided for all connections to equipment furnished by this Contractor, other Contractors, or the Using Agency.

B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-adhesive label with black letters. Text shall be 3/16-inch high.

C. Identification shall indicate source and circuit number serving the device (i.e. “L1E-3”) and voltage of the equipment if it is not 120 volts, single phase.

3.4 BOX LABELING

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. Critical: Orange

3. Optional Emergency Branch: Yellow
4. Temperature Control/Building Automation: Blue
5. Box color to match conduit color indicated below.

3.5 CONDUIT COLOR CODING SCHEDULE

A. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:

1. Fire Alarm System: Red.
2. Normal Power Distribution System: Grey.
3. Emergency Power Distribution System: Orange.
4. Temperature Controls, Motor Control and Other Control Systems: Blue
5. Low Voltage and Telephone: Black.
6. Security System: Yellow.
7. Ground: Green.

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.

C. This Contractor shall furnish and install framed 8" x 10" charts of the color coded identification scheme used for the electrical system in all electrical rooms and next to the main fire alarm panel.

3.6 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. 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.

C. Wire and cables smaller than 6 AWG shall be color coded by the manufacturer.

D. 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.

E. 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.

F. 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

3.7 CONTROL EQUIPMENT IDENTIFICATION

A. Provide identification on the front of all control equipment, such as disconnect switches, starters, VFDs, contactors, motor control centers, 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"

3.8 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.

3.9 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-30
480V: 208Y/120V 15KVA
FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELECTRIC ROOM)

3.10 POLE IDENTIFICATION

A. Lighting poles, bollards and overhead distribution poles shall be individually identified with a unique number, for maintenance purposes. Apply the vinyl label number above the hand hole cover or 24" above grade. Bollards may be identified with a number applied inside the luminaire that is visible from the exterior.

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. Selective coordination analysis and report.
C. Arc-flash hazard analysis and report.

1.2 SUBMITTALS

A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections and shall bear the seal/signature of the licensed Professional Engineer who performed 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.

1.3 SCOPE

A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis, selective coordination analysis and arc flash hazard analysis.

B. Contractor is required to provide a fully coordinated system for the essential electrical system and the associated normal side of each transfer switch and all other locations indicated on the one line diagram. Contractor shall provide overcurrent protective devices with the appropriate models, frame sizes, trip units, etc. as required to provide a selectively coordinated system.

PART 2 - PRODUCTS

2.1 Power systems study shall be completed in Power Tools for Windows (PTW) 7.0 or later version or pre-approved equivalent program.

PART 3 - EXECUTION

3.1 SHORT-CIRCUIT ANALYSIS

A. Provide a complete short-circuit analysis from the medium voltage campus service 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 SELECTIVE COORDINATION ANALYSIS

A. Provide a complete selective coordination analysis, comparing time/current curves of the protective devices to be installed to assure complete selectivity between main and downstream devices for code-required branches and branches identified on one-line drawings. Overcurrent protective devices serving the essential electrical system shall

selectively coordinate for the period of time that a fault's duration extends beyond 0.01 second.

B. The analysis shall include primary protective device, secondary main switchboard device(s), switchboard branch feeder devices, generator breaker, distribution panel, panelboard main devices, and branch feeder devices.

C. The coordination plots provided shall indicate graphically the coordination proposed for the system on full-size log forms and shall define the types of protective devices selected, together with proposed time dial and pickup settings required. The plots shall include titles, representative one-line diagrams, legend, complete parameters for transformer(s), and complete operating bands for circuit breaker trip devices, fuses, etc.

1. The long-time region of the coordination plots shall designate the pickups required for the circuit breakers.

2. The short-time region shall indicate the magnetizing in-rush and ASA-withstand-transformer parameter, the circuit breaker, short-time and instantaneous trip devices, fuse-manufacturing tolerance bands, significant symmetrical fault currents, etc.

3. The protective device characteristics or operating bands shall be suitably indicated to reflect the actual symmetrical fault currents sensed by the device.

4. The drawings and specifications indicate the general requirements for motors, motor-starting equipment, and medium-voltage and low-voltage equipment, but additional specific requirements of equipment furnished shall be determined in accordance with the results of the coordination study.

a. The study shall include verification of equipment ratings and settings. The Contractor shall keep the study up-to-date with any project changes which affect the study and submit the revised study for review. A final electronic copy shall be submitted with the record drawings.

D. Provide summary table of adjustable overcurrent protective devices settings for the operating and maintenance manual.

3.3 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, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) 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^2.

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:

1. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.

2. 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).

G. 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.

H. 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.

I. 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.

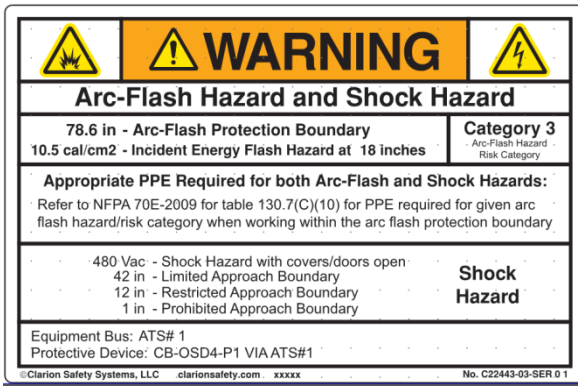
J. Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section.

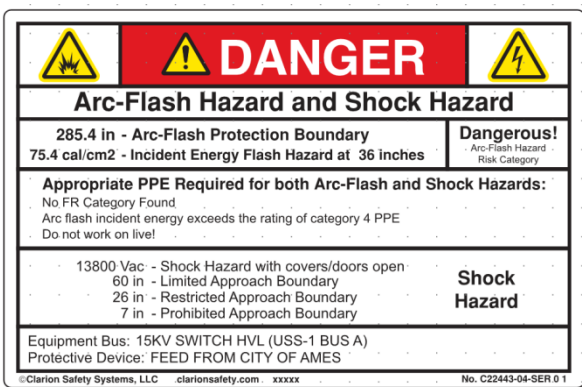
K. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.

M. 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.

N. Examples showing the minimum required information follow:





O. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.

3.4 ADJUSTMENTS

A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study.

3.5 TRAINING

A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

END OF SECTION 26 05 73

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning is the process for ensuring that the Electrical System is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Electrical System from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:

1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
3. Verify O&M documentation submitted is complete. Provide required documentation and information to the General Contractor. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
5. Furnish labor and material to accomplish electrical system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

A. Section 01 91 13 - General Commissioning Requirements.

B. Section 01 91 14 – Functional Testing Requirements

C. Division 26 Sections pertaining to the electrical systems included in the commissioning program.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the

maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.

B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.

C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.

D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the installation certification forms provided by the CxP.

E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.

F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the CxP.

3.2 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.4 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION 26 08 00

SECTION 26 09 16 - ELECTRICAL CONTROLS AND RELAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pushbutton Operators

PART 2 - PRODUCTS

2.1 **[ES]:** EMERGENCY STOP

A. Red mushroom head, (1) N.O. (1) N.C. contact, turn to release, provide engraved nameplate to read “Boiler Emergency Shutoff”.

1. Approved Manufacturers: Square D XAL K178H7, Cutler Hammer, General Electric, Siemens.

2.2 **[EPO]:** EMERGENCY POWER OFF

A. Mushroom head, (1) N.O. (1) N.C. contacts, 120 volt, turn to release, provide engraved nameplate to read “Emergency Shutoff”. Provide guarded enclosure cover to protect from accidental operation.

1. Approved Manufacturers: Square D 9001 XB5AS8445, Cutler Hammer, General Electric, Siemens 52PA2W2A.

2.3 **[ST]:** SHUNT TRIP

A. Trips breaker electrically using a remote 2-wire control source. Verify voltage with application prior to ordering.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide remote control connection to remote devices.

END OF SECTION 26 09 16

SECTION 26 12 19 - PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Liquid-filled, Pad-Mounted Distribution Transformers **[DTR-#]**

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in distribution transformers with three (3) years documented experience.

1.3 REFERENCES (Use the latest revision of referenced standards.)

A. ANSI C57.12.70 - American National Standard Terminal Markings and Connections for Distribution and Power Transformers

B. ASTM D877.02e1 - Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

C. Department of Energy 10 CFR Part 431 - Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.

D. IEEE C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, & Regulating Transformers

E. IEEE C57.12.28 - Standard for Pad-Mounted Equipment - Enclosure Integrity

F. IEEE C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage & Below. (combines C57.12.22 and C57.12.26 of past.)

G. IEEE C57.12.80 - IEEE Standard Terminology for Power and Distribution Transformers

H. IEEE C57.12.90 - Standard Test Code for Liquid-Immersed Distribution Power, and Regulating Transformers

I. IEEE C57.106 - Guide for Acceptance and Maintenance of Insulating Oil in Equipment

J. IEEE C57.111 - Guide for Acceptance of Silicone Insulating Fluid and Its Maintenance in Transformers

K. IEEE C57.121 - Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers

L. NEMA 260 - Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas

M. NEMA TR 1-1993 (R2000) - Transformers, Regulators and Reactors, Table 0-2 Audible Sound Levels for Liquid-Immersed Power Transformers.

N. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association). Sections specific to transformers.

O. Standards for Component Devices Related to Transformer Installation When Specified:

1. IEEE 386 - Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V

2. IEEE C57.13 - Standard Requirements for Instrument Transformers

3. UL 489 - Molded Case Circuit Breakers

1.4 SUBMITTALS

A. Submit shop drawings and product data under the provisions of Section 26 05 00.

B. Shop drawings shall indicate electrical characteristics and field connection details, outline dimensions, connection and support points, weight, specified ratings and materials.

C. All of the transformer nameplate information shall be supplied on the submittal drawings. The transformer impedance information shall be part of the submittal information.

D. Where transformers are being supplied with integral fuses all details as to fuse make, fuse model, fuse ampere rating, and fuse time current curves applicable to transformer high voltage shall be supplied.

E. Coordination Drawings: Floor plans drawn to scale and coordinating floor penetrations and floor-mounted items. Show the following:

1. Underground primary and secondary conduit stub-up location.

2. Dimensioned concrete base, outline of transformer, and required clearances.

3. Ground rod and grounding cable locations.

F. Submit manufacturer's installation instructions under provisions of Section 26 05 00.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Section 26 05 00.

B. Protect transformers in storage from moisture by using appropriate heaters if instructed by the manufacturer.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of *Section* 26 05 00.

B. Include procedures for sampling and maintaining fluid, cleaning unit, and replacing components.

PART 2 - PRODUCTS

2.1 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

A. Acceptable manufacturers in alphabetical order:

1. Cooper Power Systems
2. General Electric

3. Howard Industries, Inc.
4. Schneider/Square D

B. Installation service conditions:

1. The transformer(s) shall be installed outdoors.

2. The transformer will be used within C57.12.00 usual service conditions as follows:

a. The cooling air ambient temperature shall not exceed 40°C (104°F), and the average temperature of the cooling air for any 24-hour period shall not exceed 30°C (86°F).

b. The top liquid temperature of the transformer, when it is operating, shall not be lower than minus 20°C (minus 4°F).

c. The altitude shall not exceed 1000 meters/3300 feet.

C. Description: Liquid-filled, pad-mounted, three-phase, two-winding transformers. Construction shall allow installation in locations accessible to the general public without the need for protective fencing or vaults.

D. The transformer shall be UL listed as follows:

1. The transformer shall have a UL Combination Listing/Classification Mark per UL XPLH. A Listing Mark combined with a Classification Mark shall be provided for transformers with less flammable liquid that have been additionally investigated by UL in accordance with NEC Article 450.23. This combination shall include the following UL marking: “ALSO CLASSIFIED FOR USE AS LESS-FLAMMABLE LIQUID-INSULATED TRANSFORMER IN ACCORDANCE WITH SEC. 450-23 OF THE NATIONAL ELECTRIC CODE (NEC) AND MARKED USE RESTRICTIONS ON THE TRANSFORMER.”

E. The transformer electrical power frequency shall be 60 hertz.

F. Transformer kVA shall be as specified on the project drawings. The transformers shall be self-cooled, and not have any forced cooling means, such as fans.

G. The transformer coils shall be wound with aluminum conductors.

H. The transformer primary/high voltage shall be as shown on the project drawings. The primary/high voltage winding configuration as delta or grounded-wye shall be as shown on the project drawings.

I. The transformer high voltage basic lightning impulse level BIL shall be 95 kV.

J. The transformer secondary/low voltage shall be as shown on the project drawings. The secondary/low voltage winding configuration as wye or delta shall be as shown on the project drawings. Where wye windings are specified, there shall be provisions for bonding the neutral terminal to ground at the transformer terminations.

K. The transformer low voltage BIL shall be 30 kV.

L. The transformer shall have a tap changer with the following full capacity, high voltage taps. The taps shall only be changed with the transformer de-energized. Provide an

externally operable tap changer with tap position indicator and a means to padlock the tap changer at each position:

1. Four 2.5% taps below rated, nominal voltage.

M. The transformer average winding temperature rise above ambient temperature at the transformer rating shall be as follows. The transformer shall be capable of being operated at rated load in a 30°C average ambient over 24 hours and a 40°C maximum ambient without loss of service life:

1. 55°C rise above ambient.

N. Transformer percent impedance, as measured at the rated, nominal voltage connection, shall be per the following target impedances: The tolerance on the target impedances shall be ± 7.5% of nominal value for impedance target values greater than 2.5%.

1. Transformers with low voltage less than 600 VAC:

a. 750 to 3750 kVA: Impedance target shall be 5.75%. Manufacturer shall submit target impedance on submittal.

O. The transformer dielectric, liquid coolant shall be as follows:

1. Less flammable, edible seed oil (natural ester) transformer fluid: Provide a fluid that is UL listed as complying with NFPA 70, Article 450 requirements for a fire point of not less than 300°C. The fluid shall be non toxic and be readily and completely biodegradable per EPA OPPTS 835.3100.

P. High Voltage Bushings and Terminals.

1. High voltage bushings shall be installed in the high voltage compartment located on the front left of the transformer.

2. The bushing style shall be: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

a. Bushing-Well Inserts: One for each high-voltage bushing well.
b. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
c. Parking Stands: One for each high-voltage bushing well.
d. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

Q. Low Voltage Bushings and Terminals:

1. Low voltage bushings shall be supplied in the low voltage compartment located on the front right of the transformer.

2. Transformers with a low voltage of 600 volts or less shall be provided with tin-plated, spade-type bushings. The bushings shall be externally replaceable. The bushings shall be designed for vertical cable takeoff. The quantity of connection holes shall be 4, 6, 8, 12, 16, or 20 holes as necessary for the transformer low voltage conductor terminations. The spacing of the connection 9/16-inch holes shall be 1.75 inches on center per C57.12.34. Standard and maximum bushing hole quantities shall be as follows:

a. 750-1500 kVA. 480Y/277 V:6-holes standard

3. For transformers with a low voltage of 600 volts or less, bushing supports shall be provided for transformers that have ten or more connection holes.

4. For transformers with a low voltage of 600 volts or less, the bushing configuration shall be capable of terminating the number of cables allowed by the number of bushing holes specified.

R. Surge Arresters: External, distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. The transformer shall have three arresters for radial-feed.

S. Transformer Tank and Cabinet Enclosure:

1. The high voltage and low voltage compartments shall be located side-by-side on one side of the transformer tank. The compartments shall be separated by a metal barrier. The access door to the high voltage compartment shall be provided whereby the high voltage compartment door can only be opened after the door to the low voltage compartment has been opened. There shall be one or more fastening devices that must be removed before the high voltage compartment door can be opened. The low voltage compartment door shall have, as a minimum, a three-point latching system with a handle with provisions for a pad lock. Door hardware shall be made of corrosion resistant material.

2. A recessed, captive, penta-head or hex-head bolt that meets the requirements of C57.12.28 shall secure all access doors. The transformer shall meet all tamper resistance requirements of C57.12.28.

3. The tank base shall be designed to allow skidding or rolling in any direction. Lifting lugs shall be provided on the tank to allow the transformer to be lifted from above. Jacking provisions shall be provided.

4. The transformer shall be of a sealed tank construction. The tank shall be able to withstand a pressure of 7 psi without any permanent deformation and a pressure of 15 psi without rupture.

5. The tank cover shall be welded and the transformer tank hand hole fastenings shall be tamper resistant.

6. The tank shall include a 15 psig pressure relief valve. The pressure relief valve capacity flow rate at 15 psig shall comply with UL listing requirements and in no case shall be less than 35 SCFM. The pressure relief device shall be self-sealing with an indicator.

7. The transformer exterior shall be painted olive-green color Munsell 7GY3.29/1.5. The interior of the transformer cabinets shall be painted for corrosion resistance. The cabinet interior shall be painted a light color for ease of viewing. The tank coating/painting shall meet all requirements of ANSI C57.12.28, including salt spray, cross hatch adhesion, humidity, impact, oil resistance, ultraviolet accelerated weathering, and abrasion resistance.

T. Accessories: The following accessories shall be provided on the pad-mounted liquid-filled transformers.

1. Nameplate in the low voltage compartment.
2. 1-inch upper fill plug.
3. 1-inch drain/sampling valve in low voltage compartment.
4. Dial-type thermometer gauge.
5. Liquid-level gauge.
6. Pressure-vacuum gauge.
7. Cover mounted, pressure relief device. Device shall be self-sealing with an indicator.
8. Mounting provisions for low voltage current transformers.
9. Mounting provisions for low voltage potential transformers.

U. Transformer Sound Level: The transformer sound level, as measured by the NEMA audible sound-level test procedure, shall be less than the values specified in NEMA TR 1 for liquid –filled transformers.

V. Factory Standard Tests: The transformer shall be factory tested in accordance with IEEE C57.12.90. Tests include:

1. Ratio tests using all tap settings.
2. Polarity and phase relation tests.
3. No-Load losses tests.
4. Load loss tests.
5. Excitation current tests.
6. Percent Impedance at rated current.
7. Winding resistance measurement tests.
8. Induced and applied potential tests.
9. Full wave and reduced wave impulse test.
10. Mechanical leak test.

W. Certification of Transformer Tests: Provide certification of all design and other tests listed in C57.12.00, including verification that the design has passed short circuit criteria per IEEE C57.12.00 and C57.12.90.

2.2 IDENTIFICATION DEVICES (PROJECT EQUIPMENT TAGS)

A. Equipment Tag Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section 26 05 53. (This is not the manufacturer's nameplate but the equipment tag for the specific use on the project.)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that the transformer foundation/pads are ready to receive work.

B. Verify field dimensional measurements are as shown on the transformer shop drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install safety labels to NEMA 260.

C. Install plumb and level.

D. Install transformers, except for overhead pole type, on concrete bases.

1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at the Project, and requirements in Division 26 Section "Seismic Controls for Electrical Work".

2. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.

3. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete Cast-in-Place Concrete (Limited Applications)".

4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

5. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base and anchor into structural concrete floor.

6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 FIELD QUALITY CONTROL

A. Field testing will be performed under provisions of Section 26 05 00.

B. Inspect and test in accordance with NETA Acceptance Testing Specifications (ATS), except Section 4.

C. Perform inspections and tests listed in NEMA ATS, Section 7 relative to the NTEA category type “Transformers Liquid-Filled”. Include the following optional tests:

1. In addition to the standard electrical tests, perform the following optional tests when applicable:

a. Measure the percentage of oxygen in the gas blanket if a nitrogen gas blanket is provided.

2. In addition to insulating liquid standard tests, also include the following optional liquid tests:

a. Specific gravity: ANSI/ASTM D 1298.
b. Water in insulating liquids: ASTM D 1533.
c. Power-factor or dissipation-factor in accordance with ASTM D924.

3.4 ADJUSTING

A. Adjust primary/high voltage taps so that secondary voltage is within 2% of rated voltage at projected load. Verify the projected load with Architect/Engineer prior to final settings.

END OF SECTION 26 12 19

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. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers

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, NEMA TP 1; factory-assembled, air cooled dry type transformers; ratings as shown on the drawings.

B. Insulation system and average winding temperature rise for rated KVA as follows:

Ratings	Class	Rise (degree C)
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: Maximum sound levels are as follows:

KVA Rating	Sound Level
10-50	45 dB
51-150	50 dB
151-300	55 dB

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.

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 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Main and distribution switchboards**: [SB-#]**

1.2 RELATED SECTIONS AND WORK

A. Refer to the One-Line Diagram for size, rating, and configuration.

1.3 REFERENCES

A. ANSI C12 - Code for Electricity Metering

B. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments

C. ANSI C57.13 - Requirements for Instrument Transformers

D. NEMA AB 1 - Molded Case Circuit Breakers

E. NEMA KS 1 - Enclosed Switches

F. NEMA PB 2 - Dead Front Distribution Switchboards

G. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or less

1.4 SUBMITTALS

A. Submit product data under provisions of Section 26 05 00.

B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

C. Submit manufacturer's instructions under provisions of Section 26 05 00.

1.5 SPARE PARTS

A. Keys: Furnish four each to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Section 26 05 00.

B. Deliver in 48 inch maximum width shipping splits, unless approved otherwise by both the Contractor and Architect/Engineer, individually wrapped for protection, and mounted on shipping skids.

C. Store and protect products under provisions of Section 26 05 00.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 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 GENERAL

A. Approved Manufacturers:

1. Square D Class 2700 QED-2, QMB, I-Line, Powerstyle
2. General Electric
3. Siemens
4. Cutler Hammer

2.2 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. Refer to 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 switchboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.3 SWITCHBOARD CONSTRUCTION AND RATINGS

A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB2, and complete from incoming line terminals to load-side terminations.

B. Switchboard electrical ratings and configurations as shown on the drawings.

C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials used.

D. Main Section Devices: Individually mounted and compartmented.

E. Distribution Section Devices: Group mounted.

F. Auxiliary Section Devices: Individually mounted and compartmented.

G. Bus Material: Aluminum with tin plating, sized in accordance with NEMA PB 2.

H. Bus Connections: Bolted, accessible from front only for maintenance. Plug-on connections may be utilized with Architect/Engineer's pre-approval by addenda.

I. Bus bars shall be fully isolated, braced for minimum ampere rms symmetrical rating as indicated on drawings.

J. The bus shall extend the full height of the distribution sections to provide space for future breakers.

K. Provide a 1 X 1/4 inch copper ground bus through the length of the switchboard.

L. Enclosure shall be NEMA PB 2; Type 1 - General-Purpose. Sections shall align at front and rear.

M. Switchboard Height: NEMA PB 2; 92 inches, excluding floor sills, lifting members and pull boxes.

N. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

O. Pull Box: Same construction as switchboard, size as shown on the drawings. Top and sides shall be removable. Insulating, fire-resistive bottom with separate openings for each circuit to pass into switchboard.

P. Future Provisions: In addition to the spare devices shown, provide a minimum of 15 inches of fully equipped space for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.

Q. Suitable for use as service entrance equipment.

2.4 SWITCHING AND OVER-CURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. **Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole.**

B. Solid State Molded Case Circuit Breakers: **(All breakers identified on plans as solid-state with 2,500 ampere frame sizes and below.)** Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover.

2.5 INSTRUMENTS AND SENSORS

A. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding, unless otherwise required for application, and secondary

shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13; 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

C. **[DPM]:** Digital AC Power Monitor. Capable of measuring, calculating and directly displaying; Volts (L-L, L-N), Amps, KW, KWH. Monitor shall be true RMS measurement with programmable set-up parameters. All set-up parameters data shall be stored in non-volatile memory to protect from power outages.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboard in locations shown on the drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

3.2 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each. Test voltage shall be 1000 volts, and minimum acceptable value for insulation resistance is 2 megohms.

C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.

3.3 ADJUSTING AND CLEANING

A. Adjust all operating mechanisms for free mechanical movement.

B. Touch up scratched or marred surfaces to match original finish.

C. Adjust trip and time delay settings to values as scheduled, or as instructed by the Architect/Engineer.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Service and 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 FU 1 – Low voltage cartridge fuses

C. NEMA KS 1 - Enclosed Switches

D. NEMA PB 1 - Panelboards

E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less

F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment

G. UL 248 – Low-Voltage Fuses

H. 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 MAIN AND DISTRIBUTION PANELBOARDS

A. General

1. Approved Manufacturers:

a. Square D QMB, I-Line
b. General Electric Spectra ADS
c. Siemens F2, P4
d. Cutler Hammer PRL4, PRL5

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 with 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: 100,000 amperes rms symmetrical for 240 volt panelboards; 50,000 amperes rms symmetrical for 480 volt panelboards, or as shown on the drawings.

H. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

I. Solid State Molded Case Circuit Breakers: Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover.

J. Suitable for use as service entrance equipment.

2.3 BRANCH CIRCUIT PANELBOARDS

A. General

1. Approved Manufacturers:

a. Square D NQ, NF
b. General Electric AQ, AE
c. Siemens P1
d. Cutler Hammer PRL1, PRL2

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 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 circuit breakers UL listed as Type SWD for lighting circuits. 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. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

B. 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-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service

D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)

E. FS W-P-115 - Power Distribution Panel

F. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted

G. IEEE Standard 519-1981 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters

H. NEMA AB 1 - Molded Case Circuit Breakers

I. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies

J. NEMA ICS 6 - Enclosures for Industrial Controls and Systems

K. NEMA KS 1 - Enclosed Switches

L. NEMA PB 1 - Panelboards

M. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00.

B. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; wiring diagrams that differentiate between manufacturer-installed and field-installed wiring; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.

D. Submit manufacturer's instructions under provisions of Section 26 05 00.

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 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 05 00.

B. Deliver in 60 inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.

C. Store and protect products under provisions of Section 26 05 00.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from fumes, dirt, water, construction debris, traffic, and physical damage.

E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.7 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 including GFCI and/or weather resistant
C. Wall switches
D. Wall dimmers
E. Local daylighting controls
F. Indoor occupancy and vacancy sensors
G. Emergency transfer device

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. FS W-S-896 - Switch, Toggle

D. NEMA WD 1 – General Color Requirements for Wiring Devices

E. NEMA WD 6 – Wiring Devices – Dimensional Requirements

F. UL 498 – Standard for Attachment Plugs and Receptacles

G. UL 943 – Standard for Ground Fault Circuit Interrupters

H. UL 1472 – Solid-State Dimming Controls

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.

C. Submit manufacturer occupancy 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.

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 switch, receptacle, outlet, and coverplate colors shall be verified with Architect, unless indicated otherwise.

2.2 COVERPLATES

A. All switches, 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, Pass & Seymour 5362, 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. Approved Manufacturers: Hubbell GF20L, Leviton 7899, Pass & Seymour 2095, Cooper VGF20.

E. **[REC-DUP-GFI-R]**: Remote Ground Fault Device:

1. Ground fault device for remote downstream receptacles. 125 volt, 20 amp. Test and reset buttons in impact resistance thermoplastic face.

2. Approved Manufacturers: Hubbell GFBF20, Leviton 6895, Pass & Seymour 2085, Cooper VGFD20.

F. **[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. Approved Manufacturers: Hubbell GFTR20/(RW57300), Leviton W7899-TR/(5977-CL), Pass & Seymour 2095TRWR/(WIUC10-C), Cooper TWRVGF20/(WIU-1).

G. **[REC-SIM-L530R]**: NEMA L5-30R Simplex Receptacle, Locking Type:

1. 125 volt, 30 amp, 2-pole, 3-wire grounding type, with impact resistant thermoplastic face.

2. Approved Manufacturers: Hubbell HBL9308, Leviton 5371, Pass & Seymour 3802, Cooper 5716N.

H. **[REC-SIM-620R]**: NEMA 6-20R Simplex Receptacle:

1. 250 volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.

2. Approved Manufacturers: Hubbell, Leviton, Pass & Seymour L530, Cooper L530R.

I. **[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.

J. **[REC-REMOTE]**: Duplex Receptacle with Wireless Controller:

1. 5-20R duplex receptacle, 125 volt, 20 amp, 3-wire ground type. Device is controlled by associated remote controller.

2. Approved Manufacturers: Heath Zenith SL-6020-WH.

K. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.

L. Side wired devices shall have four binding screws that are undercut for positive wire retention.

M. 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.

2.4 WALL SWITCHES

A. Refer to Electrical Symbols List for device type.

B. **[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, Pass & Seymour PS20AC1, Cooper AH1221.

C. **[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: Watt Stopper TS-400, Hubbell Automation TD200.

D. **[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 Owner.

2. Approved Manufacturers: Hubbell HBL1221L, Leviton 1221-2L, Pass & Seymour PS20AC1-L, Cooper AH1221L.

E. **[SW-1P-LH]**: Lighted Handle Single Pole Switch:

1. 120 volt maintained contact. Toggle handle. Light on when contact open (switch off). Side and back wired.

2. Approved Manufacturers: Hubbell HBL1221ILC, Leviton 1221-LHC, Pass & Seymour PS20AC1-CSL, Cooper 2221LTW.

F. **[SW-1P-M]**: Momentary Contact Single Pole Switch:

1. 120/277 volt, 20 amp. Center off toggle spring return handle.

2. Approved Manufacturers: Hubbell HBL1557, Leviton 1257, Pass & Seymour 1251, Cooper 1995.

G. **[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.

H. **[SW-CS-2B]**: Low Voltage On/Off Pushbutton Switch:

1. Low voltage on/off pushbutton station, with RJ45 ports.

2. Approved Manufacturers: Watt Stopper LMSW-102, NLight, Lutron.

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, Pass & Seymour PS20AC3, Cooper AH1223.

2.5 WALL DIMMERS

A. UL listed with integral air-gap switch for on/off control.

B. Integral EMI/RFI suppression.

C. Non-viewable heat sink.

D. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.

E. Dimmer to match device color.

F. **[SW-CS-D]**: Wall Dimmer Switch:

1. Low voltage wall dimmer switch with RJ45 ports. Upper half of the switch shall be on or raise control, the lower half shall be off or lower control.

2. Approved Manufacturers: Watt Stopper LMDM-101, NLight, Lutron.

G. **[SW-CS-D-5D]**: 5-Button Scene/Zone Switch:

1. Low voltage switch for control of four preset scenes and raise/lower control, with RJ45 ports.

2. Approved Manufacturers: Watt Stopper LMSW-105, NLight, Lutron.

2.6 LOCAL DAYLIGHTING CONTROLS

A. Standalone Interior Photo Sensors:

1. **[SW-LS]**: Daylight Level Sensor - On/Off and 0-10V Dimming Control – Multi-Zone:

a. Range of 10-200 FC. Adjustable deadband prevents cycling. Adjustable time delay. Low voltage device with RJ45 ports.

b. Approved Manufacturers: Watt Stopper LMLS-500, NLight, Lutron.

2. Sensor shall detect changes in ambient light level and provide triggering of lighting groups in area based on sequence of operation.

3. Sensor shall be configurable via DIP switches at device or via handheld wireless remote programming unit. Settings shall include:

a. Ambient sensitivity range between 1 and 1,000 foot-candles.
b. Time delay of 5 to 300 seconds.
c. Trigger setpoints with deadband adjustment.

4. Sensor shall provide on/off setpoints in quantity as specified on drawings, and as shown in the sequence of operation.

5. Sensor shall be ceiling- or wall-mounted for range and viewing angle meeting application requirements as outlined in the sequence of operation.

6. Output signal from sensor shall be linear with light level.

B. **[SW-LS-PC]:** Standalone Exterior Photo Sensors:

1. Sensor shall be within a weatherproof enclosure, with design operation in temperatures of -30°F to +130°F. Sensor shall have threaded stem for box mounting, with knuckle to permit aiming of receptor after installation. Sensor shall be mounted facing north.

2. Sensor shall contain an integral switching contactor rated for 27 volt operation, with loads of up to 1,800 VA. Contacts shall be configured for zero0crodding closure to provide 100,000 cycle minimum operation.

3. Sensor shall detect changes in daylight levels to provide triggering of exterior lighting equipment based on the sequence of operation.

4. Sensors shall be field configurable at the device or via handheld wireless remote controller. Configurable settings shall include:

   a. Ambient sensitivity rang of 5 to 1,500 foot-candles.
   b. Adjustable setpoint.
   c. Deadband adjustment by percentage of setpoint.
   d. Time delay of up to five minutes.

5. Sensor shall be equipped with a lens cover that can be applied for system testing during daylight conditions.

6. Approved Manufacturers: Paragon, Tork, Intermatic.

2.7 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.

1. 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 require a manual switch operation to turn lights on and off, with a time delay for turning lights off when unoccupied.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

3. Relay Unit: 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. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by NFPA 70.

4. Mounting:

   a. Sensor: Suitable for mounting in any position on a standard outlet box.

b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.

c. Time Delay and Sensitivity Adjustments: Recessed and concealed.

5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.

6. Bypass Switch: Override the on function in case of sensor failure.

7. Power Supply and Slave Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.

8. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.

9. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.

10. Warranty: Five (5) year warranty.

B. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.

1. **[SW-OC-D], [SW-VS-D]**: 360 Degree Coverage Pattern:

a. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: ambient sensor 40 FC.

b. Manual or auto on operation. Set device to manual-on where vacancy sensors [SW-VS-D] are specified. Set device to auto-on where occupancy sensors [SW-OC-D] are specified.

c. Approved Manufacturers: Watt Stopper LMDC-100, NLight, Lutron.

2. Sensitivity Adjustment: Separate for each sensing technology.

3. 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.

C. Mask sensors where necessary to prevent nuisance switching from adjacent areas.

D. PIR Type: Detect occupancy by sensing a combination of heat and movement in area of coverage.

1. **[SW-OC-P-O]**: Wall Switch Vacancy Sensor:

a. Passive infrared, zero crossing circuitry, adjustable sensitivity and time delay, no minimum load requirements, Initial settings: 10 minutes, ambient sensor 40 FC. Manual ON for vacancy sensing.

b. Approved Manufacturers: Watt Stopper PW-100 Series, Sensor Switch WSX, Hubbell LHIRS1 or AP1277, Leviton ODS15, Greengate OSW-P-0451.

2.8 **[SW-GTD]** EMERGENCY TRANSFER DEVICE

A. All luminaires shown on the Drawings as “switched emergency” with an “SE” designation shall be provided with a UL 924 emergency transfer device, except for luminaire in Competition 1000 and Field House 1001. Refer to Specification Section 26 55 61 for device to use in these two spaces.

B. The device shall switch the luminaire input power between a switched normal lighting circuit and an emergency lighting circuit. An unswitched portion of the normal lighting circuit shall be connected to the device for mounting. Upon loss of voltage, the device shall switch to the emergency circuit.

C. Device shall be suitable with 0-10 volts dimming system.

D. Device shall be rated for the ampacity of the luminaire and suitable for use on 120-277 volts.

E. Device shall be factory or field installed integral to the luminaire, If space is not available within the luminaire ballast compartment, the device shall be field installed in an accessible location above the ceiling per manufacturer’s requirements.

F. Refer to wiring diagram shown on Drawings.

G. Acceptable Manufacturers:

1. Bodine GTD
2. Side Lite PSM
3. Dual Lite ATSD

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install light switches, dimmers, and convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.

B. 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.

C. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.

D. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.

E. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

F. Install devices and wall plates flush and level.

G. Contractor to verify that wall dimmer ratings are achieved where a ganged installation is used.

H. 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.

I. Identify locations of power packs, control units, and relays above ceiling on record drawing.

J. Test receptacles for proper polarity, ground continuity and compliance with requirements.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fuses
B. Spare Fuse Cabinet

1.2 REFERENCES

A. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Types

B. UL 198E - Class R Fuses

C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)

D. NEMA FU 1 - Low Voltage Cartridge Fuses

E. NFPA 70 – National Electrical Code

1.3 EXTRA MATERIALS

A. Provide two fuse pullers.

B. Provide three of each size and type of fuse installed.

1.4 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40°F (5°C) or more than 100°F (38°C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – FUSES

A. Cooper Bussman
B. Eagle Electric Mfg. Co.; Cooper Industries
C. Mersen
D. Tracor; Littelfuse Subsidiary

2.2 FUSES

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.

D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.

E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.

F. Control transformer fuses: Class CC (time delay).

G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch- (1.27-mm-) thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses where indicated on the drawings and specifications.

B. Install fuses in accordance with manufacturer's instruction.

C. Install fuses in packaged equipment as required by equipment manufacturer.

D. Install fuse with label oriented such that manufacturer, type, and size are easily read.

E. Install spare fuse cabinet in the Main Electrical Room.

END OF SECTION 26 28 13

SECTION 26 28 16 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fusible switches
B. Non-fusible switches
C. Enclosures

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.

3.2 ADJUSTING

A. Set field-adjustable circuit breaker trip ranges.

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 **[C-#], [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 29 23 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Variable frequency drives **[VFD-#]**

1.2 RELATED SECTIONS AND WORK

A. Refer to the Variable Frequency Drive Schedule for rating and configuration.

1.3 REFERENCES

A. ANSI/UL Standard 508

B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems

C. IEEE Standard 519-1992 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters

D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00.

B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

C. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

E. Provide harmonic distortion analysis of total service to prove variable frequency drives proposed do not exceed the latest version of IEEE 519 voltage and current distortion limits as shown in Table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

1.5 EXTRA MATERIAL

A. Furnish under provisions of Section 26 05 00.

B. Provide two of each air filter.

C. Provide three of each fuse size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 26 05 00.

B. Accept controllers on site in original packing. Inspect for damage.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 05 00.

B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.

C. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

D. Shop Drawings: For each VFD.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.

b. Nameplate legends.

c. Short-circuit current rating of integrated unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS: Refer to Variable Frequency Drive Schedule.

2.2 DESCRIPTION

A. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The controller shall be suitable for use with standard NEMA B squirrel cage 1.15 service factor induction motors without requiring any modifications to the motor or the drive.

B. Controller shall have sufficient capacity to provide speed control of the motors shown or noted throughout the specified environmental operating conditions.

C. Controller shall have the functional components listed below:

1. Door interlocked input circuit breaker/fused switch.
2. Input rectifier section to supply fixed DC bus voltage.
3. Smoothing reactor for DC bus.
4. DC bus capacitors.
5. Control transformer.

6. Separate terminal blocks for power and control wiring.
7. Terminal block for operator controls.
8. Sine weighted PWM generating inverter section.

2.3 RATINGS

A. Rated Input Voltage: Refer to Variable Frequency Drive Schedule.

B. Motor Nameplate (Drive Output) Voltage: Refer to Variable Frequency Drive Schedule.

C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.

D. Operating Ambient: 0°C to 40°C.

E. Minimum Relative Humidity Range: 5% to 90% (non-condensing).

F. Minimum Elevation without Derating: 3300 feet.

G. Minimum Efficiency at Full Load: 96 percent.

H. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.

I. Starting Torque: 100 percent of rated torque or as indicated.

J. Speed Regulation: Plus or minus 1 percent with no motor derating.

2.4 DESIGN

A. Pulse Width Modulated (PWM) Variable Frequency Drives:

1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section.

2. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz. If derating of the inverter is necessary to run at 8kHz, then the unit's derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.

3. All controllers supplied with semi-conductors capable of switching at less than 8,000 Hertz shall be supplied with a motor acoustic noise reduction filter.

4. Pulse width modulated (PWM) drives shall be supplied with drive input line reactors with a minimum impedance of 3%. Reactors shall be installed to filter entire drive input circuit.

5. Drives that are located beyond the manufacturer's recommended maximum distance from the motor shall be provided with dV/dt (long lead) filters.

B. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.

C. Drive shall restart after power loss and under-voltage fault. The minimum number of restart attempts required shall be three, field adjustable.

D. The drive shall allow unlimited switching of the output without damage to the drive or motor.

2.5 PRODUCT FEATURES

A. Display: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current.

B. Protection:

1. Input transient protection by means of surge suppressors.

2. Snubber networks to protect against malfunctions due to system transients,

3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.

4. Motor thermal overload relay(s) adjustable and capable of NEMA Class 10 20 30 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.

5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.

6. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.

7. Loss-of-phase protection.

8. Reverse-phase protection.

9. Short-circuit protection (fuses or circuit breaker).

10. Motor overtemperature fault.

C. Acceleration Rate Adjustment: 0.5 - 30 seconds.

D. Deceleration Rate Adjustment: 1 - 30 seconds.

E. Minimum Adjustment Range for the Lower Output Frequency shall be: 0 to 40 Hertz.

F. Minimum Adjustment Range for the Upper Output Frequency Range shall be: 40 to 90 Hertz.

G. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.

H. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.

I. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.

J. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.

K. Provide adjustable skip frequencies on the drive output (minimum of three ranges).

L. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

M. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

Q. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

S. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:

a. 0 to 10-V dc.
b. 0-20 or 4-20 mA.
c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.

e. RS485.
f. Keypad display for local hand operation.

3. Output Signal Interface:

a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

1) Output frequency (Hz).
2) Output current (load).
3) DC-link voltage (VDC).
4) Motor torque (percent).
5) Motor speed (rpm).
6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:

a. Motor running.
b. Set-point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

T. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 09 00. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.

U. Control:

1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door.

2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.

3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.

4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.

5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass.

6. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

2.6 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

F. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

G. Fabrication:

1. Enclosure: NEMA 250, Type 1.
2. Finish: Manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The VFD manufacturer shall provide certification that heat test has been completed.

B. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.

3.2 INSTALLATION

A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.

B. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.

C. Provide engraved phenolic nameplates under the provisions of Section 26 05 53.

D. Connections: All conduit connections to the VFD shall be by flexible conduit.

E. Input, output, and control wiring shall each be run in separate conduits.

F. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.

3.3 STARTUP AND COMMISSIONING

A. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.

B. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.

C. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.

D. Document settings in the Operations and Maintenance manual.

END OF SECTION 26 29 23

SECTION 26 35 00 - UNIT POWER CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Unit power conditioners **[UPC-#]**

1.2 REFERENCES

A. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

B. ANSI/NEMA ST20 - Dry Type Transformers for General Applications

C. NEMA AB1 - Molded Case Circuit Breakers

D. NEMA PB1 - Panelboards

1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 26 05 00.

B. Submit shop drawings indicating cable lengths and construction, circuit arrangements and directory, control system wiring diagram, connection diagram for external wiring, and details of conduit and wiring connections and terminations.

C. Product Data: Provide electrical characteristics and connection requirements for unit and accessories.

1.4 EXTRA MATERIALS

A. Provide one cable and connector of each size and type.

B. Provide one set of control circuit fuses.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Section 26 05 00.

B. Store and protect products under provisions of Section 26 05 00.

C. Accept products on site and verify damage.

D. Protect products from moisture and dust by storing them in a clean, dry location remote from areas involved in construction operations. Provide additional protection in accordance with manufacturer's instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit manufacturer's operation and maintenance data under provisions of Section 26 05 00.

B. Include operating instructions for start-up and resetting unit.

C. Include maintenance instructions for cleaning methods, recommended cleaning materials, addition and modification of branch circuit arrangements, repair and parts replacement.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum of three (3) years documented experience, and with service facilities within 100 miles of the project.

1.8 MAINTENANCE SERVICE

A. Furnish service and maintenance of power conditioning systems for one (1) year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Controlled Power Company – Series 700A.

2.2 UNIT POWER CONDITIONER

A. Description: Unit power conditioner suitable for underfloor cable connection to data processing equipment, including surge protection, harmonic filters, isolation transformer, and voltage regulation.

B. System Continuous Rating: As indicated on the drawings.

C. Input Voltage Rating: 480Y/277 volts, 3 phase.

D. Output Voltage Rating: 208Y/120 volts, 3 phase.

E. Impedance: 3 percent, maximum.

F. Input Voltage Limits: +10, -20 percent.

G. Frequency: 60 ±3 Hertz.

H. Load Power Factor: Capable of operating between 60 percent lagging and 60 percent leading power factor.

I. Harmonic Distortion of Input Current Wave Form: 5 percent maximum at full load.

J. Output Voltage Regulation: +6, -8 percent.

K. Output Harmonic Distortion: Maximum 2 percent rms total harmonic distortion.

L. Three-phase Overload Ratings:

1. 500 percent for 1 cycle.

2. 100 percent for 10 seconds.

M. Response Time: 100 percent correction in 1 cycles.

N. Audible Noise: Less than 52 dBA at a distance of 3 feet in non-reverberating environment.

O. Efficiency: 90 percent minimum over operating range.

P. Normal Mode Attenuation: 32 dB, 10 Hertz to 1 MHz.

Q. Common Mode Attenuation: 126 dB.

R. Environmental Conditions: Operate satisfactorily when environment is maintained between 32°F and 104°F, and less than 95 percent humidity (non-condensing).

2.3 DRY TYPE ISOLATION TRANSFORMER

A. Isolation Transformer: ANSI/NEMA ST 20; factory-assembled, air cooled dry type shielded isolation transformer, ratings to match unit ratings specified. Comply with UL 1561, including requirements for nonsinusoidal load current handling capability defined by designated K-factor.

B. Insulation System: Class 220C, with 150°C average winding temperature rise.

C. Winding Taps: ANSI/NEMA ST 20.

D. Sound Levels: ANSI/NEMA ST 20.

E. Ground core coil assembly to enclosure using a visible flexible copper grounding strap.

F. Electrostatic Shielding: Independently shield each winding with a double-copper, electrostatic shield arranged to minimize interwinding capacitance.

1. Provide electrostatic winding shield with separate insulated grounding connection.

2. Coil leads and terminal trips shall be arranged to minimize capacitive coupling between input and output connections.

3. Shield Terminal: Separate and marked “Shiled” for grounding connection.

4. Capacitance: Limit capacitance between primary and secondary windings to a maximum of 33 pico-farads over a frequency range of 20 Hz to 1 MHz.

5. Common-Mode Noise Attenuation: 120 dB minimum, 0.5 top 1.5 kHz; minus 65 dB minimum, 1.5 100 kHz.

6. Normal-Mode Noise Attenuation: Minus 52 dB minimum, 1.5 to 10 kHz.

G. Coil Conductors: Continuous windings with terminations brazed or welded.

H. Isolate core and coil from enclosure using vibration-absorbing mounts.

I. Cores: Grain oriented, non-againg silicon steel, one leg per phase.

J. Output impedance: 3 to 5 percent.

K. Taps: 6 full capacity, compensation taps at 2.5 percent increments; 2 above and 4 below nominal voltage.

L. Full-Load Efficiency: 96 to 98 percent at rated load.

2.4 CONTROLS AND INDICATORS

A. Include the following control features:

1. Emergency, power-off switch integral with power distribution unit.

2. Emergency, power-off input terminals for connection to remote power-off switch.

3. Over-under alarm shutdown with automatic unit disconnection for the following alarm conditions:

a. High temperature.

b. High and low input or output voltage.

c. Phase loss.

d. Ground fault.

e. Reverse phase rotation. Ground fault protection with automatic system shutdown.

4. Alarm Contacts: Electrically isolated, Form C (one normally open and one normally closed), summary alarm; contact sect shall change state if any monitored function goes into alarm mode.

5. Remote Power-Off Control: 30-V ac control circuit with connection to shunt trip of power distribution unit main power circuit breaker and terminals for connection one or more remote power-off, push-button stations.

B. AC input circuit breaker; INDICATOR TEST switch; Red and green.

C. Indicators: Provide audible and visual alarm indication of abnormal conditions:

1. Output Over-voltage: Higher than 6 percent above rated.

2. Output Under-voltage: Less than 13 percent below rated.

3. Transformer Over-temperature: Temperature higher than 180°C.

4. Phase loss.

5. Ground fault.

6. Freqency.

7. Phase rotation.

8. TVSS modulate failure.

9. Audible Alarm and Silencing Switch: Alarm sounds when alarm indication occurs. Silencing switch shall silence audible alarm but leave visual indication intact until failure or other alarm conditions are corrected.

D. Meters: Use 1 percent accuracy meters. Use electronic sensing with digital display.

1. Voltage: Input and output, phase-phase and phase-neutral.

2. Current: Input and output, each phase; output neutral current; ground current.

3. Apparent Power: Output KVA.

2.5 ACCESSORIES

A. Integrated TVSS system complying with Division 26 Section Surge Protection Devices, to protect unit panelboard and have the following features:

1. Disconnect Device: Manual, three-pole, fused disconnect switch to de-energize TVSS system while permitting power distribution units to continue operation. Fuses are rated at 200-kVA interrupting capacity.

B. Power Supply Junction Box: Watertight box, with terminal blocks for connection of incoming power feeder circuit, and connector for input cable.

C. Input Cable: Field verify feet length, cable made up of building wire in liquid-tight flexible metal conduit.

D. Control Circuit Junction Box: Watertight box, with terminal blocks for connection of control and interlock circuits, and connector for cable to unit.

E. Control Cable: Field verify feet length, cable made up of building wire in liquid-tight flexible metal conduit.

F. Output Cables: Fabricate output cables using copper building wire and liquid-tight flexible metal conduit, field verify feet in length.

G. Remote Emergency Power Off Switches: Switch assembly with normally open contact mounted in painted wall box. Provide 12 feet of three conductor cable for connection to unit.

H. Transient Suppression Plate: Copper, 3 feet square.

2.6 FABRICATION

A. Electroplate brackets and securing hardware with corrosion resistant material. Secure bolts, studs and nuts with lockwashers.

B. Identify internal wiring at each end of conductor. Provide cabinet grounding lug.

C. Enclosure: ANSI/NEMA 250, Type 1 enclosure allowing access from front for servicing adjustments and locations, with access through hinged door equipped with tumbler lock and latch handle. Equip cabinet for fork truck lifting.

D. Equip air inlet with permanent filters and pressurize cabinet or use gaskets around door and panel openings to prevent entry of dirt.

E. Cooling: Forced convection or natural convection.

F. Component Ratings: To achieve expected service life of twenty (20) years continuous duty, ten (10) years without component replacement.

G. Cabinet finish: Primed and painted inside and outside with manufacturer's standard finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as shown on the shop drawings, or as indicated by the manufacturer.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Verify that available supply voltage is within required input voltage limits.

C. Assure that unit(s) are properly grounded.

3.3 MANUFACTURER'S FIELD SERVICES

A. Commission system(s) under provisions of Section 26 05 00.

B. Include check of system, energizing system, and verification of proper operation.

END OF SECTION 26 35 00

SECTION 26 36 00 - TRANSFER SWITCH

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Automatic transfer switch **[ATS-#]**

1.2 RELATED SECTIONS AND WORK

A. Refer to the Transfer Switch Schedule for rating and configuration.

1.3 QUALITY ASSURANCE

A. Manufacturer: Company specializing in automatic transfer equipment with three (3) years documented experience.

1.4 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control and Systems

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies

C. NEMA ICS 2-447 - AC Automatic Transfer Switches

D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems

E. UL 1008 - Standard for Automatic Transfer Switches

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00.

B. Submit product data for transfer switches showing overall dimensions, electrical connections, electrical ratings, and environmental requirements.

C. Submit manufacturer's installation instructions under provisions of Section 26 05 00.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 05 00.

B. Include instructions for operating equipment.

C. Include instructions for operating equipment under emergency conditions when engine generator is running.

D. Identify operating limits which may result in hazardous or unsafe conditions.

E. Document ratings of equipment and each major component.

F. Include routine preventive maintenance and lubrication schedule.

G. List special tools, maintenance materials, and replacement parts.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for emergency and standby electrical systems.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ASCO.
B. Russelectric, Inc.
C. Zenith Controls, Inc.

2.2 AUTOMATIC TRANSFER SWITCH

A. Description: NEMA ICS 2; automatic transfer switch.

B. Configuration: Electrically-operated, mechanically-held transfer switch.

C. Control panel shall be micro-processor based.

2.3 SERVICE CONDITIONS

A. Service Conditions: NEMA ICS 1.

2.4 RATINGS

A. Refer to the one-line diagrams for the available interrupting capacity (AIC) of the transfer switch. The transfer switch shall be series rated with the equipment feeding the transfer switch. The series rating shall be the larger of the two AIC values when the AIC rating of the equipment feeding the normal and emergency sides of the transfer switch is not equal.

B. Series rating with upstream devices shall be allowed per UL-1008.

2.5 AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

B. Time Delay to Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable.

C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.

D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.

E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.

G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.

H. Engine Exerciser: Start engine every seven (7) days. Run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.

2.6 ENCLOSURE

A. Enclosure: NEMA ICS 6; Type 1.

2.7 ACCESSORIES

A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.

B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.

C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

D. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed indicating switch to normal source or emergency source.

E. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value, values shall be field adjustable.

F. Alternate Source Monitor: Monitor each line of alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent Hertz from rated nominal voltage, values shall be field adjustable.

G. In-Phase Monitor: Inhibit transfer until source and load are within 30 electrical degrees.

H. Switched Neutral: Overlapping or fully rated 4th pole contacts.

I. Provide 2 N.O. and 2 N.C. isolated contacts to indicate:

1. Normal source available.
2. Emergency source available.
3. Exercise mode in operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as instructed by the manufacturer.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide wiring to elevator controller for emergency source mode and emergency to normal presignal.

END OF SECTION 26 36 00

SECTION 26 43 00 - SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes materials and installation requirements for low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated service entrance equipment and distribution panels.

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 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage (VPR).

3. A single 8 x 20µs 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 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 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 50µs 10kV or 20kV open circuit voltage waveform and an 8 x 20µs 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-C3]:** Service Entrance Suppressors:

1. For 277/480 volt, 3 phase, 4 wire, type 2, category C3 unit.

a. Surge current capacity: 80,000/160,000 amps per protection mode/phase

b. Nominal Discharge Current: 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).

f. Disconnect: Surge-rated disconnect with 200,000 SCCR.

2. Approved Manufacturers:

a. Square D Surelogic EMA Series
b. Siemens TPS3 Series
c. Cutler Hammer SPD Series
d. Current Technology Current Guard Plus
e. Emerson Network Power 560 Series
f. LEA International LSS Series

B. **[SPD-B3L]:** Secondary Distribution Suppressors:

1. For 120/208 volt, 3 phase, 4 wire, type 2, category B3/C1 unit.

   a. Surge current capacity: 60,000/120,000 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. Square D Surgelogic EMA Series
   b. Siemens/APT TPS3 Series
   c. Cutler Hammer SPD Series
   d. Current Technology Current Guard Plus
   e. Emerson Network Power 510 Series
   f. LEA International CFS Series

C. **[SPD-B3H]:** Secondary Distribution Suppressors:

1. For 277/480 volt, 3 phase, 4 wire, type 2, category B3/C1 unit.

   a. Surge current capacity: 60,000/120,000 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. Square D Surgelogic EMA Series
   b. Siemens/APT TPS3 Series
   c. Cutler Hammer SPD Series
   d. Current Technology Current Guard Plus
   e. Emerson Network Power 510 Series
   f. LEA International CFS Series

D. Voltage Protection Rating:

1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).

   a. 277/480 Volt, 3 phase, 4 wire.1200 Volt L-N, L-G, N-G and 1800 Volt L-L

b. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L

E. 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.

F. 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 service entrance and secondary distribution type unit(s) with a transient counter.

4. Each unit shall contain form “C” contacts for remote indication of an alarm status.

G. 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 switchboard or panel using a conduit nipple. Flush mount the unit in the front of the switchboard. 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 switchboard/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
C. Poles

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

D. Project site classification as defined in IESNA RP-33 LZ3

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. Submit utility rebate forms, where offered at project location, with rebate items completed.

F. 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.

G. 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.

H. LEED Requirements:

1. Light Pollution Reduction:

a. Exterior Luminaires: Submit manufacturer data showing percentage of light lumens emitted at or above 90° from nadir for each luminaire type.

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.

C. Handle site lighting poles carefully to prevent breakage and damage to finish.

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. Fountain and pool luminaires shall be listed for submersible location to meet depth specified.

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.

2.4 ACCEPTABLE MANUFACTURERS - POLES

A. Manufacturer of Luminaire.
B. Valmont Poles.
C. U. S. Pole Company.
D. KW Industries

2.5 LIGHTING POLES

A. Metal Poles: Round straight steel lighting pole with embedded anchor transformer base.

B. Wind Load: 100 MPH velocity, with 1.3 gust factor with luminaires and brackets mounted.

C. Hand Hole: 2 x 4 inches with removable weatherproof cover installed at manufacturer's standard location. Provide matching gasketed cover plate.

D. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole. Grout between anchor plate and concrete base with non-shrink grout after pole is plumbed.

E. Vibration Damper: Canister or snake type second mode vibration damper internal to the pole as recommended by pole manufacturer. Provide additional pole top damper for first mode vibration on single-head poles where recommended by manufacturer.

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^2) 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. Parabolic louvers and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.

H. Industrial Pendant Luminaires: Use hangers rated 500 pounds minimum or provide safety chain between ballast and structure. Provide safety chain between reflector and ballast.

I. Luminaire Pole Bases: Sized and constructed as indicated on the drawings. Project anchor bolts 2 inches minimum above base. Install poles plumb with double nuts for adjustment. Grout around pole anchor base.

J. Embedded Luminaire Poles: Depth as indicated. Install plumb.

K. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

L. Fire-rated Ceilings: Support luminaires independent of ceiling system with a minimum of two (2) #12 gauge wires.

3.2 LAMP SEASONING

A. Operate all fluorescent and HID lamps for 100 hours prior to requesting final observation. Operate dimming fluorescent lamps at 100% output during seasoning. Operate lamps for minimum 8 hour intervals during seasoning.

3.3 RELAMPING

A. Replace failed lamps at completion of work. Replacement of incandescent and other lamp burnouts after the warranty period starts shall be the responsibility of the final user.

3.4 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 and pole finish at completion of work.

3.5 LUMINAIRE SCHEDULE

A. As shown on the drawings.

END OF SECTION 26 51 00

SECTION 26 55 61 – STAGE/FIELD HOUSE LIGHTING CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Touchscreen Control Station
B. Lighting Control Panel
C. Button Station
D. Relay Panel
E. DMX Gateway Port
F. Automatic Load Control Relay
G. Daylight Level Sensor

1.2 SYSTEM DESCRIPTION AN DWORK INCLUDED

A. The systems shall be designed for the control of the Field House and architectural lighting and shall consist of factory pre-wired dimming and processing rack enclosures containing dimmers, control electronics, power supplies, breakers, and terminals.

B. Provide, install and test a complete lighting control system as specified herein for areas indicated on the drawings and circuit schedules. Coordinate to ensure that all necessary components are furnished and installed to provide a complete system.

C. Furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the lighting control system

D. Coordinate all work described in this section with all other applicable plans and specifications, including but not limited to:

1. General Conditions
2. Electrical Section General Provisions
3. Conduit
4. Wire and Cable
5. Manufactured Wiring Assemblies
6. Theatrical Rigging Systems

1.3 REFERENCES

A. ANSI/NFPA 70 National Electrical Code

1.4 SUBMITTALS

A. Submittals shall include:

1. Full system riser diagram(s) illustrating interconnection of system components, wiring requirements, back box sizes and any special installation considerations.

2. Full set of printed technical data sheets.

3. Detailed set of dimmer schedules

4. Detailed set of circuit and control schedules, including complete list of any and all deviations from specifications.

B. Submit manufacturer’s installation instructions under provisions of Section 26 05 00.

1.5 PROJECT RECORD DOCUMENTS

A. Submit project record documents under provisions of Section 26 05 00.

B. Accurately record location of Lighting Control Panel and control enclosures. Include description of switching and circuiting arrangements.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 05 00.

B. Include replacement part numbers.

1.7 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of 10 years continuous experience in the manufacturing of theatrical lighting control equipment.

B. Proposed equipment shall be UL and C-UL listed, and/or CE marked (where applicable) and bears the appropriate labels.

1.8 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 years from date of commissioning.

1.9 COMMISSIONING

A. System shall be completely commissioned by a factory-authorized engineer. 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 dimming system. The commission shall include demonstrating and educating the owner's representative(s) on the system capabilities, operation and maintenance.

B. The contractor shall notify the architect/engineer and owner's representative ten working days prior to scheduled commissioning date. Training of the owner's representative(s) on the system capabilities, operation and maintenance shall be a minimum of four (4) hours.

PART 2 - PRODUCTS

2.1 [FH-TS]: TOUCHSCREEN CONTROL STATION

A. Approved Manufacturers:

1. Electronic Theatre Controls Unison Paradigm Touchscreen, or approved equal.

B. LCD touchscreen stations shall support default and fully graphical control pages. The touchscreen station shall operate using graphic buttons, faders and other images on at least 20 separate programmable control pages.

C. Touchscreen stations shall also allow programming of page pass-code, lock out and visibility levels.

D. Coordinate finish selection with Architect.

E. Touchscreen shall connect to lighting control system using an Ethernet network with Power over Ethernet (PoE).

F. Operation

1. The Field House lighting control system shall be designed to allow control of lighting and associated systems via Touchscreen controls. System shall allow the control of presets, sequences, macros and time clock events.

2. System presets shall be programmable.

3. Presets shall have a discrete fade time.

4. Presets shall be selectable via the touchscreen station.

5. System time clock events shall be programmable via the Touchscreen, the processor user interface, or the internal web server.

6. Touchscreen stations shall be designed to operate standard default or custom system functions. Components shall operate default functions unless re-assigned via the Windows-based configuration program.

a. Optional button functions include: preset selection, manual mode activation, record mode activation, station lockout, raise, lower, macro activation, and cue light, or room join/separate.

b. Optional fader functions include master control, individual channel control, fade rate control or preset master control.

G. It shall be possible to adjust LCD contrast and brightness.

H. It shall be possible to program the station to dim during periods of inactivity.3

2.2 [FH-LCP]: LIGHTING CONTROL PANEL

A. Approved Manufacturers:

1. Electronic Theatre Controls Unison Paradigm, or approved equal.

B. The lighting control system shall provide data distribution over TCP/IP Ethernet networks. Data shall be layer 3 routable. Systems using proprietary formats or formats other than 10/100/100Mbit wired Ethernet or non-layer 3 routable networks shall not be accepted.

C. The Lighting Control system must be supplied by a single manufacturer and must have seamless integration over Ethernet between the Entertainment and Architectural lighting control.

D. The network shall support DMX routing, patching, and prioritization for up to 63,399 universes (32,767,488 DMX addresses). Each address may be input or output from any port on any DMX gateway in the system. DMX input, routing and output shall be specifically supported on the system from multiple sources and locations up to the maximum number of gateways supported by the Ethernet topology.

E. Wall mount. Top, bottom, and side knockouts shall facilitate conduit entry.

F. Panel shall include:

1. The Ethernet Switch module shall contain power, status, and activity indicators.

2. Redundant Power Supply

a. The panel shall be provided with redundant power supply which shall automatically provide power to the control electronics upon failure or removal of the primary power supply.

b. The redundant power supply shall provide visible indication that it is active.

3. Battery Backup

a. The panel shall support an optional, short-term back-up power source for the control electronics.

b. Backup power provides power for controls electronics during brief power outages or drop outs.

c. The short-term back-up power source shall automatically engage upon the loss of normal power, seamlessly transitioning the supply power for the control electronics power to itself.

d. The short-term back-up power supply shall detect the return of normal power, and seamlessly return the control electronics to normal power.

e. The short-term back-up power source shall support the control electronics for at least 10 seconds.

G. Electrical:

1. Panel shall be 120 volt, single-phase.

2. Panel shall be completely pre-wired by the manufacturer. The contractor shall provide input and control wiring.

3. External Processing enclosures shall be designed to support the following wire terminations:

a. AC (single phase)

b. Echelon link power (Belden 8471 or equivalent)

c. 24Vdc (2- 16AWG Wire)

d. DMX512A Port A (In or Out) (Belden 9729 or equivalent)

e. DMX512A Port B (In or Out) (Belden 9729 or equivalent)

f. RS232 Serial In/Out (Belden 9729 or equivalent)

g. Unshielded Twisted Pair (UTP) Category 5 Ethernet

h. Contact Closure In (14AWG to 26AWG Wire)

i. Contact Closure Out (14AWG to 26AWG Wire)

H. Architectural Control Processor Modules

1. The processor shall utilize microprocessor based, solid state technology to provide multi-scene lighting and building control.

2. The Architectural Control Processor (ACP) shall be convection cooled.

3. User Interface

a. The ACP shall utilize a backlit liquid crystal display capable of graphics and minimum of eight lines of text.

b. The ACP shall provide an alpha-numeric keypad for data entry and navigation

c. The ACP shall provide a touch-sensitive control wheel for navigation.

d. The ACP shall provide shortcut buttons to assist in navigation, selection, and data entry.

e. The ACP keypad, buttons, and wheel shall be backlit for use in low-light conditions.

1) The backlight shall have a user selectable time out, including no time out.

4. The ACP shall provide a front-panel RJ45 receptacle for Ethernet connection to the processor for configuration, live control, and web-browser-based system access.

5. The ACP shall include the following on the front of the panel for transfer of configuration data:

a. Secure Digital (SD) Removable Media slot.

b. Universal Serial Bus (USB) port.

6. The ACP shall support 10/100BaseTX, auto MDI/MDIX, 802.3af compliant Ethernet networking using TCP/IP, ESTA BSR E1.17 Advanced Control Networks (ACN) and ESTA BSR E1.31 (sACN) Protocols for internal communication and integration with third-party equipment.

a. The ACP shall support EIA-RS232 serial protocol for bi-directional command and communication with third-party equipment.

b. The ACP shall support two discrete ESTA DMX512A ports, configurable as input or output ports.

c. The ACP shall provide four onboard dry contact closure inputs for integration with third-party products.

d. The ACP shall provide four onboard contact closure outputs, rated at 1A@30VDC, for integration with third-party equipment.

7. Functional

a. Capacity

1) Shall support minimum of 1024 channels of control

2) Shall support 2 physical DMX ports, each of which may be configured as an input or output

b. Diagnostics

1) Shall output an Event log

2) Standard log shall store a fixed-length history of recent activity

3) Separate critical log shall only store important messages (such as boot-up settings)

c. Configuration Data

1) Configuration Data can be uploaded over an Ethernet connection from a PC running Light Designer application

2) Configuration Data may be loaded to and from removable media access provided on front panel

d. Local User Interface

1) Shall provide access to system setup (IP address)

2) Shall provide access to system status and diagnostics

3) Shall provide control functionality for Control Channels, Zones, Fixtures, Groups, Presets, Macros, Walls and Sequences within the current configuration.

4) Shall provide functionality to schedule astronomical and real time events (add/edit/delete)

5) Shall allow for display of local DMX information

6) Shall allow for transfer of log files to local removable media

e. Web User Interface

1) Shall support common web browsers on Windows and Mac platforms

2) Shall provide functionality to schedule timed events (add/delete)

3) Shall display status information

4) Shall display log files

f. The processor shall provide DMX-Net3 gateway functionality

g. Net3 devices shall be connected to and controlled from the processor via Ethernet

I. Station power modules (SPM)

1. Power modules shall energize button, button/fader, touchscreen, and interface devices for multi-scene lighting and building control.

2. Power modules shall utilize light emitting diodes (LED' s) to indication function, status and fault.

3. Electrical

a. The SPM shall require line-voltage power supplied by the contractor, terminated inside the dimming or control enclosure.

b. The SPM shall be hot-swap capable.

c. The SPM, in conjunction with a matching Lighting Control Processor, shall support Echelon LinkPower communications with remote devices, including button, button/fader, touchscreen and interface stations, and shall interoperate with LonMARK-approved third-party devices.

1) The LinkPower network shall utilize polarity-independent, low-voltage Class II twisted pair wiring, type Belden 8471 (unshielded) or Belden 8719 (shielded) or equivalent. One # 14 AWG drain wire will be required for system not using grounded metal conduit.

2) The LinkPower network shall be topology free. Network wiring may be bus, loop, home run, star or any combination of these.

3) Link power wiring shall permit a total wire run of 1640 ft.

a) Repeaters allow an additional wire run of 1640 ft.

b) Dual-repeaters allow two additional wire runs of 1640 ft.

4) Link power wiring between stations shall not exceed 1313 ft.

d. The SPM shall support auxiliary power for certain remote devices, including touchscreen and interface stations, as required by the device.

1) The auxiliary power network shall utilize polarity-dependent, low-voltage Class II wiring, consisting of two # 16 AWG wires.

2) Auxiliary wiring shall permit a total wire run of 1640 ft.

a) Repeaters allow an additional wire run of 1640 ft.

b) Dual-repeaters allow two additional wire runs of 1640 ft.

3) The SPM shall supply 1.25 amps at 24v DC continuously.

4. Functional

a. Capacity - each SPM shall

1) Supply power for up to 32 button and button/fader stations.

a) Repeaters and dual-repeaters allow 30 additional stations, 62 total

2) Supply auxiliary power for a similar number of interface stations.

3) Shall supply auxiliary power for up to four Touchscreen stations, when a like number of other stations are deducted from the total.

b. Operation

1) The SPM shall not require configuration or programming.

2) The SPM shall automatically detect faults in the wiring, indicate the fault, including the fault polarity, and shut down the output power.

a) The SPM shall automatically reset when the fault is clear, and can be manually reset by removing and re-inserting the module.

2.3 [FH-BS]: BUTTON STATION

A. Approved Manufacturers:

1. Electronic Theatre Controls Unison Unison Heritage, or approved equal

B. Stations

1. Button stations shall operate using up to ten programmable buttons. Coordinate with floor plan drawings for quantity of buttons.

2. Coordinate faceplate finish selection with Architect. .

3. Stations shall have indicator lights at each button or fader.

a. Indicators shall be comprised of red, green and blue LED's

b. Indicator color and state (steady On, Blink, Off) shall be configured in software, and shall operate relative to the button or fader it is associated with.

4. All faceplates shall be designed for flush or surface mounting.

5. Station faceplates shall be indelibly marked for each button or fader function.

6. The control station shall be designed to allow control of lighting and associated systems via Button, Button/Fader, and Interface or Astronomical time clock controls. System shall allow the programming of presets, sequences, macros and time clock events.

7. Individual control station shall have the capabilities to lockout other control stations within the lighting control system.

8. Control stations with subscript “W” on the floor plan shall be provided with wire guard.

2.4 [FH-RLY-#] RELAY PANEL

A. Approved Manufacturers:

1. Electronic Theatre Controls Unison Echo Relay Panel, or approved equal

B. The Relay Panel shall consist of a main enclosure, relay sub panel, integral control electronics, and a low voltage subpanel for data terminations and provision for up to three accessory cards

C. Panel shall be surface wall mounted.

D. Relay override panel shall provide 24 button overrides which allow the user to directly change the state of any or all relays at the panel.

1. Relay overrides shall be available for each relay which indicate current state of the relay by way of LED indicator

2. Numerical circuit number reference which matches the relay to its breaker

3. Removable load schedule label shall be provided which allows the customer to name each of the relay circuits

E. Relay output lugs shall accept 6-14AWG copper wire

F. The control wiring shall land on a removable header for easy contractor installation (On-board DMX, station, and Emergency Input terminations).

G. User Interface

1. The user interface shall contain a graphical display with button pad to include 0-9 number entry, up, down back arrow navigation and enter.

2. Test shortcut button shall be available for local activation of preset, sequence and set level overrides.

3. The user interface shall have a power status LED indicator (Blue), a DMX status LED indicator (Green), a network status LED indicator (Green) and an LED indicator (red) for errors.

4. USB memory stick interface for uploads of setup and software updates

H. Functional

1. Panel setup shall be user programmable. The control panel shall provide the following relay setup features (per circuit):

a. Type (1 pole, 2 pole, or 3 pole)
b. Name
c. Circuit
d. DMX address
e. sACN address
f. Space
g. Circuit Mode
    1) Normal (priority and HTP based activation)
    2) Latch-lock
    3) Fluorescent

h. "On" threshold level
i. "Off" threshold level
j. Include in UL924 emergency activation
k. Allow Manual

2. The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay period of 0.1 to 60 seconds, in 0.1 second increments, per relay.

3. Control electronics shall report the following information per branch circuit:

   a. Breaker state
   b. Relay state
   c. Current draw
   d. Voltage
   e. Energy usage over time

4. Built in Control shall include:

   a. From the control panel, stations, or timed events it shall be possible to record up to 16 presets per space for up to 8 spaces per panel.

      1) Presets shall be programmable by recording current levels (as set by DMX), by entering levels on the face panel directly, manually selecting relay state on each relay, or a combination of both methods.

   b. From the control panel, stations, or timed events it shall be possible to record up to 16 zones per space.

   c. Indication of an active preset shall be visible on the LCD display.

   d. One 16-step sequence per space for power up and power down routines

   e. The panel shall have a UL924-listed contact input for use in Emergency Lighting systems. The panel shall respond to the contact input by setting relays to "on", while setting non-emergency relays "off". Each relay can be selected for activation upon contact input.

   f. Data lose behavior

5. The control of lighting and associated systems via timed and Astronomical clock controls.

6. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad. Any switch may be patched to any DMX channel.

   a. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.

   b. The relays shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz.

   c. Setting changes shall be able to be made across all, some, or just one selected relay in a single action from the face panel

d. Rack

e. Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address.

f. Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting.

7. Architectural Setup

a. DMX loss behavior
b. DMX priority
c. Station power (on/off)
d. Preset priority
e. Backlight timeout and shutoff mode
f. Contrast
g. Language
h. Spaces
i. Network settings

I. Electrical

1. Ratings:

a. 120/208 volt, 3 phase, 4 wire.
b. 277/480 volt, 3 phase, 4 wire.

2. Coordinate with drawings for required relay panel voltage rating and SCCR rating.

J. Relay

1. Each relay shall have a manual override switch with on/off status indication.
2. 16A Electronic Ballast up to 277V
3. Isolation: 4000V RMS
4. State: Latching
5. Life:
   a. 100,000 cycles at full resistive load
   b. 30,000 cycles motor, inductive, or tungsten
6. Current reporting accuracy: 5%

K. Accessories

1. The following accessories shall be optionally available:

a. Network Interface
b. Low voltage 0-10V Dimming Control
c. Ride-Thru Option
d. Main Breakers

2.5 [FH-GTWY] DMX GATEWAY PORT

A. Approved Manufacturer:

1. Electronic Theatre Controls Net3 DMX 2-port Gateway, or approved equal

B. General

1. The lighting control gateway shall be a microprocessor-based unit specifically designed to provide DMX-512 control of lighting systems and transport of RDM configuration and status messages. The gateway shall permit DMX-512 data to be encoded, routed over an Ethernet network and decoded back to DMX-512.

2. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.

3. The gateway shall support multiple protocols including:

   a. ANSI E1.17 Architecture for Control Networks (ACN)

   b. ANSI E1.31 Streaming ACN (sACN)

   c. ANSI E1.11 USITT DMX512-A

   d. ANSI E1.20 Remote Device Management (RDM)

4. The gateway shall be tested to UL standards and labeled ETL Listed.

5. The gateway shall be RoHS Compliant (lead-free).

6. The gateway shall be CE compliant.

7. The gateway shall have a backlit graphic LCD display for identification (soft-labeling) and status reporting.

   a. Labeling shall be user configurable using ANSI E1.17 Architecture for Control Network (ACN), or a purpose built software configuration tool.

   b. The LCD display shall show DMX port configuration indication as well as indicate the presence of valid signal.

   c. Gateways that do not indicate port configuration (input/output) and valid data shall not be acceptable.

8. Each gateway shall have power and network activity LEDs on both the front and rear of the gateway

C. DMX Ports

1. DMX Ports shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.

2. Each DMX port shall be software-configurable for either input or output functionality.

3. Hardware configuration override setting shall be provided on the gateway.

4. DMX input shall be optically-isolated from the gateway electronics.

5. DMX output shall be earth-ground referenced.

6. DMX Port shall be capable of withstanding fault voltages of up to 250vAC without damage.

7. Each port shall incorporate one DMX512-A Connection

   a. Each DMX port location shall support a single 5-pin male XLR or 5-pin female XLR

8. Network gateways that do not indicate input/ output port configuration or presence of valid data shall not be accepted

D. Processor

1. Each gateway shall have sufficient processing power to manage up to 63,999 universes (32,767,488 addresses).

2. Maximum delay time from input to output shall not be greater than one packet time (approximately 22 mSec.).

3. A minimum DMX update rate of 40Hz shall be sustained under all conditions unless specifically configured for a slower rate for the sake of compatibility with 3rd party DMX devices.

E. Power

1. Power for the gateway shall be provided over the Category 5 (or better) cable, utilizing IEEE 802.3af compliant Power over Ethernet (PoE). Power consumption using shall not be greater than 5 watts.

2. The gateway electronics shall be electrically isolated from the power supplied over the Catagory5 (or better) cable.

F. Accessories

1. Hanging bracket kit shall allow gateway to be mounted using C-Clamp to U-bolt Hardware.

2. A Universal Power Supply with international plug-set shall be available. Multiple power supplies shall be able to fit in a vertically stacked power strip.

3. ETC Net3 Concert Configuration and monitoring Software

2.6 [FH-ALCR] AUTOMATIC LOAD CONTROL RELAY

A. Approved Manufacturer:

1. Electronic Theatre Controls Automatic Load Control Relay, or approved equal

B. All luminaires within Competition 1000 and Field House 1001 as shown on the Drawings as “switched emergency” with an “SE” designation shall be provided with a UL 924 emergency transfer device.

C. The device shall switch the luminaire input power between a switched normal lighting circuit and an emergency lighting circuit. An unswitched portion of the normal lighting circuit shall be connected to the device for mounting. Upon loss of voltage, the device shall switch to the emergency circuit.

D. Device shall be suitable with 0-10 volts dimming system.

E. Device shall be rated for the ampacity of the luminaire and suitable for use on 120-277 volts.

F. Device shall be factory or field installed integral to the luminaire, If space is not available within the luminaire ballast compartment, the device shall be field installed in an accessible location above the ceiling per manufacturer's requirements.

G. Refer to wiring diagram shown on Drawings.

2.7 [FH-LS] DAYLIGHT LEVEL SENSOR

A. Approved Manufacturer:

1. Electronic Theatre Controls Unison Paradigm Light Sensor, or approved equal

B. Daylight Level Sensor - On/Off and 0-10V Dimming Control – Multi-Zone:

1. Range of 10-200 FC. Adjustable deadband prevents cycling. Adjustable time delay. Low voltage device with RJ45 ports.

C. Sensor shall detect changes in ambient light level and provide triggering of lighting groups in area based on sequence of operation.

D. Sensor shall be compatible with the Field House Lighting Control system. Setting within the system 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.

E. Sensor shall be suitable for high-ceiling installation – 30-feet above finished floor.

F. Output signal from sensor shall be linear with light level.

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the responsibility of the Contractor to receive and store the necessary materials and equipment for installation of the control system. It is the intent of these specifications and plans to include everything required for proper and complete installation and operation of the dimming system, even though every item may not be specifically mentioned. The contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The Contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

C. The Contractor shall install all lighting control and dimming equipment in accordance with manufacturer's approved shop drawings.

D. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals.

3.2 MANUFACTURER'S SERVICES

A. Upon completion of the installation, including testing of load circuits, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout.

B. No power shall be applied to the dimming system unless specifically authorized by written instructions from the manufacturer.

C. The Contractor shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.

D. Upon completion of the formal checkout, the factory engineer shall demonstrate operation and maintenance of the system to the owner's representative(s). A minimum allowance of eight (8) hours shall be made for programming and training by the factory engineer. Owner will have the option of videotaping all training sessions.

3.3 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions are as shown on the drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.4 INSTALLATION NOTES

A. Install in accordance with manufacturer's instructions.

B. All wiring shall be installed in conduit.

C. Allow space for adequate ventilation and circulation of air.

END OF SECTION 26 55 61

SECTION 26 55 62 – STAGE LIGHTING RIGGING HOIST SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. One company shall be responsible for the installation of all aspects of the stage rigging equipment. Work under this section shall include furnishing all labor, materials, tools, transportation services, supervision, etc., necessary to complete installation of the stage rigging equipment as well as any other items as herein listed, all as described in these specifications, as illustrated on the accompanying drawings; or as directed by the Owner' s Representative. Work includes the following:

1. Motorized Rigging

1.2 SUBSTITUTIONS

A. Specific items of equipment are specified by trade names. It has been determined by the systems designer that these are the particular items desired by the Owner and establish a standard of quality, equipment function and/or process. It is not the purpose or intent of these documents to eliminate competitive bids. In order to allow proper and fair comparison of pricing, contractors are required to submit their base bid price on the specified equipment. A contractor may submit an alternate bid based on equipment different from that specified only if that Contractor has received prior approval in writing from the Architect at least 10 days prior to bid. Accompanying each request shall be a letter specifically detailing each substitution including catalog data, specifications, operative samples, technical information, drawings, performance and test data, and complete descriptive and functional information to assist in a fair evaluation. Failure to submit any substitution for prior approval or not providing sufficient data for evaluation shall require the exact item specified to be furnished. Architect's approval of a substitution for bid purposes will not relieve the contractor from the responsibility of meeting all specification criteria. If an approval of a substitution is granted, the Contractor shall be fully responsible for any and all changes (wiring, power, distribution, support structure, etc.) such substitution shall require.

1.3 GUARANTEE

A. The Contractor shall guarantee all of the work that is performed under this contract, including all materials, and workmanship, for a period of three (3) years from the date of full acceptance of the work in accordance with the following conditions.

B. Warranty shall be in effect on materials and equipment for three years from the date of system commissioning under the following conditions:

1. Maintaining the warranty in effect requires annual inspection of the system by a factory trained and certified contractor. Continuing annual inspection is strongly encouraged.

2. The three year warranty is contingent upon annual inspection at the end of the first and second years of service. The end user is responsible for making arrangements for each inspection with the contractor identified on the Motor Controller or a factory certified inspector/installer.

3. In the event annual inspection is not requested and performed at the end of the first or second year of service, the warranty shall become void at the end of that year of service.

4. Each warranty inspection report must be sent to the factory by the inspecting contractor within 10 days of completing the inspection.

C. Nothing in this guarantee shall cause repair or replacement by the Contractor where negligence, neglect or improper operation by the Owner has caused the failure of any equipment installed under this contract.

1.4 DISCREPANCIES

A. All equipment shall be sized to fit properly. The exact measurements are the responsibility of the Contractor. If there are discrepancies in the specifications, the Contractor shall ask for a clarification from the Architect. If no clarification is requested, the Architect's judgment shall rule.

1.5 SYSTEM INTEGRATOR

A. The Contractor may utilize a System Integrator to coordinate and assist in the installation of all aspects of the motorized rigging equipment as specified in this section. This shall include but not be limited to all motorized rigging and miscellaneous equipment. The following companies have prior approval as System Integrator:

B. In order to be considered as a System Integrator on this project, each Contractor requesting approval must submit to the Architect at least ten (10) days prior to the date of bid opening a letter expressing his intent to bid. This letter shall include a list of at least five (5) projects of similar size and scope completed by this firm within the last five (5) years. Inspection of one completed installation may be requested by the Architect/Engineer's Representative prior to consideration of request to bid. The System Integrator shall have been in business under the same name for five (5) full years preceding the date of this bid doing work similar to the type specified. ETCP certification in theatre rigging is required by the lead installer or project manager of the System Integrator to receive approval to bid. Verification of this certification must be provided to be considered for approval. The decision of the Architect as to the capability of the Bidder to successfully complete and maintain the system based on this pre-qualification information shall be final.

C. Pre-Bid request letter shall include a statement that all major items of equipment shall be bid and supplied as specified, or shall contain details of all proposed substitute equipment for review by the Architect/Engineer's Representative. Substitute equipment items to include specifications, parts numbers, and details of interconnection to proposed system. The decision of the Architect as to the acceptability of substitute equipment shall be final.

D. The System Integrator shall employ only fully trained stage riggers and mechanics, for the erection of the stage equipment. The stage riggers shall be completely familiar with the type of equipment to be installed. A competent job superintendent shall be on the job at all times when work is in progress. The job superintendent must be ETCP certified in theatre rigging. A copy of the certification must be furnished to the General Contractor prior to the start of the installation.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00 and as noted below.

B. Shop drawings and equipment data sheets shall be submitted to the Architect under general provisions within 45 days after award of the contract. Failure to comply with this 45 day requirement shall be cause for disqualification of the selected Contractor and cancellation of contract without cost to the owner, on the basis that the selected Contractor does not have the ability or intention to comply with the specifications. Approval of submitted equipment shall be obtained prior to equipment purchase or fabrication. If shop drawings are rejected, correct and resubmit in the manner specified. All shop drawing information shall be submitted at the same time; no partial submittal shall be accepted. Drawings shall indicate complete details, dimensions, product types and locations of all equipment, clearances required, guides, cables, sets, Contractor fabricated equipment, and all other details required to completely describe the work to be performed. Submittals drawings shall be presented at a scale not less than 1/4" for equipment layouts and " = 1'-0" for equipment details, mounting and other details. Each sheet shall allow space for approval stamps and have the name of the project, the contractors and/or the supplier's name, address telephone number, and the date submitted. Submit the following items for Architect's approval, prior to fabrication:

1. Stage plan view
2. Stage side section view
3. Gridiron layout indicating all stage equipment
4. Electrical riser diagrams indicating the necessary power and control wiring for all rigging equipment and systems
5. Plan and elevation views indicating all power, motor and control hardware locations and layout
6. Provide full dimensions for panel layouts with finishes and materials for all custom panels
7. Details of installation and erection, including adjoining conditions and necessary clearances
8. Indication by arrow and boxed caption of each variation from contract drawing and specifications, except those indicated as acceptable in specifications or on drawings.

1.7 ACCEPTABLE MANUFACTURERS

A. For the purposes of establishing a standard of quality desired on this project, the rigging hardware products of Electronic Theatre Controls of Middleton, Wisconsin are specified.

B. All other companies must receive prior approval to bid this project. Please refer to the section regarding substitutions.

1.8 PROJECT DOCUMENTS

A. Submit documents under the provisions of Section 26 05 00

B. Three (3) complete sets of "as built and approved" drawings showing systems and elements as installed, including field modifications and adjustments

C. Three (3) sets of maintenance data including a list indicating replacement parts lists for all items of equipment, wiring diagrams, control diagrams, any and all keys for cabinets, racks, key operated switches etc. and complete operation manuals.

D. Three (3) Certificates of Guarantee

1.9 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 years from date of delivery.

B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.

C. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.

D. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization.

PART 2 - PRODUCTS

2.1 RIGGING HOIST WITH COMPRESSION TUBE

A. General

1. Hoists shall be purpose-designed and fabricated for overhead lifting of theatre lights, equipment, fixture/system wire guard, whether used on stage, in the auditorium or other places of public assembly where people shall move beneath the suspended or moving load. The systems shall incorporate mechanical, electrical and safety features that shall be inherent to this equipment; they shall provide an engineered, efficient device for overhead lifting. The mechanical, electrical and safety features of this hoisting and control system shall establish the standard of quality, performance and safety by which hoisting systems of other manufacture shall be evaluated.

2. Hoist assembly shall have the capability to be raised or lowered in multiple elevations within the Field House. Coordinate required elevation with Owner and Architect

3. Each hoist shall be fully tested under full rated load throughout its full travel distance with all its lift lines terminated to the hoist before the hoist is shipped from the manufacturer. Only hoists that successfully pass the following pre-shipment testing shall be sent to any job site. Hoists that are not tested as a complete system with the wire rope and loft blocks that will install with the hoist in the field shall not be acceptable. Testing shall include:

a. Hoist operation
b. Hoist/motor speed
c. Lift line terminations under load
d. Braking and stopping under load
e. Load cell functions
f. Slack line detection
g. Position sensing
h. Hoist noise

4. A record of testing and its results shall be available for review at the manufacturer' s facility.

5. A copy of all testing results must be furnished by the installing contractor to the architect or owner representative at the time of system commissioning. Manufacturers who cannot provide testing results shall not be acceptable.

6. Paint as required under this section shall be the manufacturer's standard finish and color except as noted.

7. All equipment items shall be new and conform to applicable provisions of Underwriters' Laboratories (UL), American Standards Association (ASA), American National Standards Institute (ANSI), National Fire Protection Association (NFPA) Life Safety Code 01, National Electric Code (NEC) and PLASA.

    a. Where acceptable equipment items are specified by catalog number only, device shall meet all published manufacturer's specifications. Where quantities or sizes are not given, refer to drawings. Where two or more products are listed, contractor may use either, at his discretion. Equipment shall not be substituted without specific written approval by the Architect under the substitution paragraphs of these specifications.
    b. All pipe battens shall be fabricated from 1.5" Schedule 40 pipe.
    c. All turnbuckles and cable clips shall be drop forged.
    d. All turnbuckles and clips, tracks, chains and other items of incidental hardware shall be furnished plated or painted. Wire rope shall be galvanized. Fasteners, chain, and other miscellaneous hardware shall be either cadmium or zinc plated.
    e. All materials used in this project shall be new, unused and of the latest design. Refurbished materials are not permitted.
    f. In order to establish minimum standards of safety, a minimum factor of 10 shall be required for all equipment and hardware used on this project. In addition, the following factors shall be used:
    g. 10 Design Factor
    h. 26 times diameter
    i. 2 degrees
    j. 1/5 of yield
    k. Two times required load at full for 2000 hours

B. HOISTS

1. Each wire rope lift line shall adhere to a design factor of 10:1 with an ultimate strength of 4200 pounds. All load path components between the building structure and the batten shall exceed the breaking strength of the wire rope. The motor brake shall be rated at least at 125% of the motor torque.

2. Hoists shall be capable of supporting the following loads:

    a. General purpose 30 fpm 2000 pound capacity in standard configuration. Powerhead shall measure 16" high x 18" w x 53 1/2" long and weigh 580 pounds

3. The standard general purpose hoist shall consist of the following major components: 1) Powerhead, 2) compression tube with beam clamps, loft blocks, lift line and lift line terminations, Right Angle Cable Adjuster (RACA) and 3) pipe batten.

4. The standard stage electric hoist shall consist of the following major components: 1) Powerhead, 2) Compression Tube with beam clamps, cable management

system, loft blocks, lift line and lift line terminations Right Angle Cable Adjuster (RACA), 3) pipe batten and power/control distribution strip

5. The hoist shall include the following features:

   a. A Powerhead containing the following elements: the gear motor, motor brake, load brake, limit switches operating electronics, load cell, slack line detector, absolute position sensors, cable drum assembly, and wire rope.

   b. A Compression Tube that prevents hoist system lateral forces from transferring to the building. Hoists or hoisting systems that impose a lateral load on the building shall not be acceptable.

   c. The hoist shall incorporate a built-in load cell.

   d. The hoist shall incorporate a built-in slack line sensor.

   e. The hoist shall include the emergency contactor built into the hoist

   f. Hoists that do not include built-in load cell, built-in slack line detection, and an emergency contactor shall not be acceptable.

   g. Hoists that do not use absolute position encoders shall not be acceptable.

6. The hoist shall be manufactured from UL Listed components and shall be UL Listed and tested as a complete system (not just UL listed parts).

C. POWERHEAD

1. The Powerhead shall be a fully enclosed, powder coated sheet metal housing that shall prevent contact with moving and electrical parts and shall provide protection against dirt, dust and debris.

2. Hoist assemblies that do not have metal housings prohibiting access to moving parts shall not be acceptable.

3. For setup and maintenance, the following functions shall be available from the Powerhead: power and operating switches, address setting knobs, limit switch setting knobs, limit switch override button, indicators for power, status and communication. Each of these functions shall be clearly labeled.

D. GEARMOTOR AND MOTOR BRAKE

1. The gear motor and motor brake shall be an integral unit from a single manufacturer. It shall operate on 208 Volt or 480 Volt 60 Hz, 3 phase current for fixed speed units and 480 Volt, 60 Hz, 3 phase current for variable speed hoists.

2. The motor brake shall be integral to the gear motor and shall be capable of holding 125% of the motor full load torque.

3. The motor brake shall be spring actuated to apply and hold braking force.

4. The motor brake shall be magnetically released and held open upon actuation.

E. LOAD BRAKE

1. Fixed Speed Hoists

    a. The rotary disk load brake shall bring the moving load to a complete stop and shall hold the load in position in the event of a mechanical failure of the motor, motor brake or gearbox.

    b. Noise from the load brake shall be minimally audible at any time in the operational cycle.

    c. Normal hoist operation shall not be limited by heat or noise caused by the load brake.

    d. The load brake shall be mechanically released when the load is moving in the up direction. The load brake shall close when the hoist has stopped. The load brake shall always be engaged when the load has stopped moving either up or down. When lowering the load the load brake shall partially disengage to allow and control descent of the batten. The load brake shall remain closed in the absence of rotational torque on the gearbox.

2. Variable Speed Hoists

    a. The rotary disk load brake shall open upon activation of hoist movement and shall close after the load has come to a stop; it shall hold the load in position.

    b. Noise from the load brake shall be minimally audible at any time in the operational cycle.

    c. Normal hoist operation shall not be limited by heat or noise caused by the load brake.

    d. The load brake shall be mechanically released when the load is moving either up or down.

F. WIRE ROPE DRUM

1. The drum shall be capable of wrapping up to eight 3/16" diameter 7 x 19 galvanized aircraft (utility) wire rope lift lines up to 50' long in a compact manner. They shall be managed by a wire rope (cable) keeper integral to the Powerhead. The drum design shall prevent wire rope from tangling or crossing over itself.

G. LIMIT SWITCH

1. A limit switch assembly shall be mounted within the Powerhead for hard "normal" and "ultimate" end of travel limits. Hard end of travel limits shall be set/adjusted at the time of installation aided by an indicator light visible on the bottom panel of the Powerhead cover. Any system that indicates that the limit has been set by audible or tactile means only shall not be acceptable.

H. LOAD SENSOR/LOAD PROFILING.

1. A load sensor shall be built into the Powerhead to create a profile of the actual load on the hoist as it travels through its normal cycle. The profile may be changed by "re-training" the profiling system whenever the suspended load is changed on the batten by activating a key-switch operated training cycle on the motor controller. The load sensor shall continuously monitor the load when load

sensing is turned on.

I. POSITION SENSOR

1. A position sensing system shall be built into the Powerhead to provide accurate position information. The system shall consist of two absolute sensor types that provide accurate position information for each batten at power-up of the system. Hoisting systems that require re-homing shall not be acceptable. Incremental encoders shall not be acceptable for position readout purposes.

J. SLACK LINE DETECTOR

1. The slack line detector shall be built into the Powerhead. When a slack line condition in excess of 15" develops in a lift line, the slack line detector shall remove power from the hoist. The batten shall be allowed to move only in the upward direction to allow removal of the cause of the slack line fault.

K. LOCAL USER INTERFACE TO POWERHEAD

1. User interface at the Powerhead control panel at the rear of the hoist shall include:

   a. Hoist Up/Down Control
   b. Limit Switch override buttons (tool accessible)
   c. Address switches
   d. Status LED' s

L. INFORMATION STORAGE WITHIN POWERHEAD

1. Record of severe fault conditions with date and time stamp

2. Record of E-stops, overloads, moves and power cycles

3. Record of travel distance and peak loads since installation/inspection

4. Hoist systems that do not record the above data shall not be acceptable.

M. COMPRESSION TUBE AND BEAM CLAMPS

1. The Compression Tube shall be a continuous channel of extruded aluminum engineered in conjunction with the beam clamps to neutralize rigging-generated lateral forces on the building.

2. The Compression Tube shall support the system loft blocks.

3. Compression Tube sections shall be joined into a continuous assembly by a pair of dedicated splicing plates at each tube joint.

4. The Compression Tube shall be installed only by means of dedicated beam clamps that allow the Compression Tube to snap into place and to fractionally move horizontally under load.

5. Beam clamps shall be capable of attaching to horizontal beams, joists, truss flanges or flat steel plates measuring from 1/4" thick up to 1" thick and from 4" wide up to 14" wide placed no more than 14' -0" apart. P650E, P800G, P1000E and P1300G Powerheads may be mounted on ¼" thick x 4" wide or larger steel structures if deemed sufficient by a structural engineer. P1500E, P1900G and

V1000S hoists must be mounted on 3/8" x 6" wide or larger steel if deemed sufficient by a structural engineer. Support structures must be deemed sufficient by a structural engineer to support any forces imposed by the hoisting systems. Beam clamps shall accommodate up to ½" vertical misalignment.

6. Hoist systems that do not neutralize hoist generated lateral forces on the building shall not be accepted for this project.

N. LOFT BLOCKS

1. Each loft block shall be an assembly of steel side plates, a wire rope idler, sheave, bearings, shaft locked against rotation and support hardware. Each loft block shall be inserted into the slot on the bottom of the Compression Tube. The blocks shall be positioned no closer than 4' -0" from each other, unless muled.

2. Loft block sheaves shall measure 5" in diameter and contain a pair of press fit sealed ball bearings. Lift lines shall travel in a groove shaped and sized for 3/16" diameter wire rope per the latest edition of the Wire Rope Users' Manual as published by the Wire Rope Technical Board. The loft block sheave shall be concentric about the hub and shall be evenly balanced for ease of rotation.

3. An idler shall be incorporated into the top assembly of the loft block to guide and support lift lines as they pass the block.

4. Hoisting systems requiring the loft blocks to be mounted directly to the facility structure shall not be accepted for this project.

O. LIFT LINE TERMINATIONS

1. Each lift line shall be terminated in the Powerhead via a standard copper oval compression sleeve installed/crimped at the factory.

2. Lift lines shall be terminated at the load hanger with a low profile Right Angle Cable Adjuster (RACA) ™, thimble and copper oval compression sleeve. The RACA and cable terminations at the batten shall be installed at the time of hoist installation.

3. Batten trim shall be adjustable up to 6" via the RACA.

4. Systems utilizing turnbuckles or chain to trim the batten shall not be accepted for this installation.

P. HANGERS

1. Raceway hangers shall be specially shaped flat bar that shall support the wire rope termination hardware and secure the raceway and the pipe batten.

Q. CABLE MANAGEMENT FOR ELECTRICS

1. PRODIGY CABLE MANAGEMENT for ELECTRICS

a. The load circuits and control wiring shall be fed to the distribution trough by a built-in cable management system that allows flat feeder cable to fold and store along the top of the connector strip.

1) At high trim, the entire system shall be stored in 30" of vertical space from the bottom of the mounting steel to the horizontal

centerline of the batten. Cable management systems requiring greater vertical storage space shall not be acceptable for this project.

2) The cable management system shall be integral to the hoist system.

3) The cable management system shall be UL LISTED.

4) The flat cable shall meet the physical as well as thermal requirements of UL for 20 amp loads. Up to four flat cables may be fed from each end of the distribution system to provide power for 24 circuits from each end of the system for a maximum of 48 total circuits.

5) Each flat cable shall include one ground wire and one data cable plus an individually insulated hot and an individually insulated neutral conductor for each of six 120 Volt 20 Amp circuits.

6) The connector strip shall be built to the length specified with outlets or pigtails located as specified or as shown on the construction drawings. Outlets or plugs shall be 15 amp grounded pin connectors, 15 amp twistlock connectors, or 15 amps Edison plugs. The distro trough may also contain connectors for Ethernet and/or DMX connections.

7) Flat cable shall pass through a strain relief before entering a termination box at the designated end of the raceway. Within the raceway all wiring shall be attached at the factory to a terminal block. The flat cable, internal wiring and all components shall meet UL requirements and appropriate National Electrical Codes (NEC).

b. Cable management systems that utilize cable cradles, cable reels or locate feeder or data cables outside the off stage edges of the electrics batten shall not be acceptable for this project.

c. Hoisting systems utilizing cable management systems from third-party vendors shall be fully integrated into the hoisting system without additional structural changes or changes to the QuickTouch controller. Electrics line set hoisting systems that do not fully integrate cable management in the hoisting system and controller shall not be acceptable for this installation. Cable management systems that are not UL LISTED shall not be accepted for this installation.

2. PANTOGRAPH CABLE MANAGEMENT FOR ELECTRICS

a. The load circuits and data wiring shall be fed to the distribution trough by one or more UL Listed Pantograph cable management systems that are specifically designed to interface with traditional stage distribution raceways. The pantograph shall allow the cable trays, feeder cable and data wiring to fold and store along the top of the connector strip without imposing a direct physical load on the connector strip.

b. The pantograph shall consist of a series of 18 ga. ventilated steel trays hinged to each other to allow the entire distance of travel required by the

batten, up to 50' . The hinges and hinge attachment points shall be stiffened to prevent distortion of the pantograph.

c. The trays shall be connected to a moving trolley at the compression tube that allows relief as the system moves slightly from side to side during ascent/descent of the batten. At the bottom, the pantograph shall be attached to a hinge point above the houselight or distribution trough in a manner that imposes no additional physical load on those assemblies. The flat cable in the trays shall exit the pantograph and enter a termination box on the distro strip where all electrical connections shall be made.

d. The flat cable shall be UL LISTED.

e. The pantograph shall support a double-high/double wide stack of flat cable and shall allow the flat cable to bend at each joint within required NEC bending radii.

f. The trays shall hinge open/closed as the batten is lowered/raised and shall not impede the movement of the line set

g. The trays shall be sufficiently stiff to support themselves and the flat cable they carry. At no time shall the trays bow, warp, sag or twist whether or not under load of the flat cable.

h. Flat cable in the pantograph tray shall never heat in excess of the rated temperature maximum of the flat cable when all circuits within the tray are loaded at maximum electrical capacity.

i. It shall be possible to provide power for up to sixteen 20 amp circuits plus ground and data via each pantograph.

j. These cable management systems shall interface with the circuit distribution trough with standard mechanical and electrical hardware purpose designed for this assembly.

k. Circuit and data terminations between the pantograph and distribution strip shall be performed by the manufacturer. Cable management systems that require terminations at the distribution trough in the field shall not be acceptable.

l. Hoisting systems utilizing cable management systems from third-party vendors shall be fully integrated into the hoisting system without additional custom hardware, changes to any part of the pantograph or changes to the QuickTouch controller.

m. Hoisting systems that do not fully integrate cable management in the hoisting system and controller shall not be acceptable for this installation.

3. TRADITIONAL CABLE MANAGEMENT FOR ELECTRICS

a. Load circuits and data wiring shall be fed to a standard stage distribution trough by multi-conductor SO cable supported by cable cradles suspended from one of the Prodigy hoist lift lines. The SO cable shall be held in place at the distro by means of a dedicated strain relief assembly.

b. Single or multiple multi-conductor SO cables and multiple cable cradles can be suspended from a single lift line so long as the Working Load Limit (WLL) of the lift line is not exceeded.

4. CONNECTOR STRIPDISTRO and HOUSELIGHT TROUGH

a. A Houselight Trough shall be a formed sheet metal trough made from 18 ga. Steel. The trough shall be reinforced with 12 ga. formed steel at each utilized fixture attachment point. The trough shall enclose internal wiring to which fixture wiring is terminated within the trough.

b. The system may incorporate an internal barrier to permit emergency circuit wiring in the same trough.

c. The trough shall be powder coated.

d. Circuit wiring shall be supplied to the trough via an ETC Pantograph cable management system.

e. Cable management shall utilize an ETC Prodigy pantograph that allows up to sixteen line-voltage circuits, or a combination of line–voltage and up to two emergency circuits. Knockouts located 6" on-center are built into the raceway. The knockouts permit installation of houselights with canopy or stem mounts to attach directly to the raceway. Up to 50 pounds may be suspended between raceway supports.

f. Pantograph cable management and houselight distribution is UL LISTED for use with flat cable circuit distribution and fixture mounting as described above.

g. Houselight troughs are designed to be used without pipe battens.

R. PIPE BATTEN

1. The pipe batten shall be 1½" schedule 40 grade A, seamless pipe fabricated in the largest possible lengths without splices. Battens of greater length shall be spliced by means of .120 x 1 9/16 dia. DOM tube 18" long with 9" of tube inserted into each half of the splice. The tight fitting splice tube shall be held in place by a pair of 3/8 x 2 ½" grade 5 hex bolts on each side of the joint. The bolts shall pass through the pipe at an angle of 90° to each other. There shall be two bolts on each side of the joint spaced 1" and 8" from the joint. Alternatively, one pair of bolts on one side of the joint may be replaced with either plug welds or tight fitting steel rivets. Pipes shall be straight and painted flat black.

2. A safety-yellow batten cap shall be installed at each end of each pipe batten.

3. The manufacturer shall provide up to four self-adhesive labels for each batten on which the rated batten load shall be written by the installer.

S. POWER AND CONTROL DISTRIBUTION (PCD)

1. Each hoist shall receive power and control via a pair of 8' -0" long cables extending from the Powerhead to the source outlets. Receptacles shall be installed in a sheet metal junction box or trough with outlets. Each outlet shall be located no more than 6' -0" away from the rear face of each hoist.

2. Each Powerhead shall include a power cord hardwired to the hoist with an

appropriately sized grounded twist-lock connector at the PCD end and a removable control cable with a circular 9 pin connector at each end. An appropriately rated 3 phase breaker in the PCD is included. The wiring and connectors shall be barriered between high and low voltage.

3. The power/distribution channel shall be UL LISTED for this application.

2.2 QUICKTOUCH FIXED SPEED CONTROL SYSTEM

A. GENERAL

1. The entire motor system shall be operated by a QuickTouch fixed speed controller. It shall be purpose-designed and fabricated to manage and operate motors specifically designed for overhead lifting. Each system shall incorporate mechanical, electrical and safety features that shall be inherent to this equipment and shall provide an engineered, efficient device to control the equipment. The mechanical, electrical and safety features of this control system shall establish the standard of quality, performance and safety by which motoring systems of other manufacture shall be evaluated.

2. The QuickTouch Control System shall consist of a surface, flush or rack mounted primary control panel and up to three remote E-stop stations.

3. The motoring system shall also include one QuickTouch Fixed Speed Remote control device with 30' of flexible cable that may be attached to the system at the QuickTouch control panel.

4. The controller shall include the following features:

   a. Key operated power switch
   b. LCD display for feedback/operating information
   c. Key operated motor load profile training/enable switch
   d. Latching motor selection buttons with rear illuminated naming tabs
   e. Rear illuminated hold-to-operate (dead-man) up and down operation buttons
   f. Dedicated E-stop button
   g. Outlet for wired remote
   h. Optional door
   i. Optional rack mount kit

5. The control system shall only employ the QuickTouch controller, a power and control distribution infrastructure and the motors. A System that requires separate drive cabinets or motor-starters shall not be acceptable.

B. ENCLOSURE

1. The back box and face panel shall be fabricated from 16ga powder coated sheet steel specially formed to provide support for installation as well as support for all components installed within the housing.

2. The QuickTouch face panel shall be printed with complete labeling information to identify the function of each of the buttons in the control station.

3. The face panel shall identify the system as a QuickTouch controller for stage rigging.

4. The face panel shall be shades of grey. The ring surrounding the E-stop button shall be safety yellow and shall be rear illuminated

5. The steel panel to which all switches are mounted shall be removable via screws in the surface located underneath the face panel film.

C. LCD SCREEN

1. The liquid crystal display shall be purpose designed to communicate all information in human readable text.

2. The screen shall be rear illuminated and shall be dimmable.

3. During system start up the screen shall show the progress of the motors diagnostics self-tests. Upon completion of the startup sequence the screen shall indicate that the system is "OK" or shall provide specific information should a fault be detected. Fault conditions shall be reported in human readable text. Systems that report fault conditions in a series of blinking lights shall not be acceptable for this installation.

4. When a motor is selected the LCD screen shall readout the motor name or number, its current position above the floor, the amount of weight suspended from the batten, the preset position that is recorded, as well as a bar graph scale that shows the current position of the motor, top and bottom limits and the current weight suspended from the motor.

D. MOTOR SELECTION/OPERATION BUTTONS

1. There shall be rear illuminated motor selection buttons. Buttons shall remain illuminated until de-selected.

2. Up to four motors may be selected to move at one time. When the up or down button is pushed and held, each motor shall move to its next stop location. If the stop location is the adjustable preset, the motor can be made to continue to travel in the selected direction by releasing and re-pressing the up or down hold-to-operate button until the next stop for the motor(s) is reached.

3. A maximum of four motors may move at one time and only in one direction at a time.

4. Although four motors moving at one time is the factory default, it shall be possible to increase to eight or reduce to one the quantity of simultaneously moving motors.

5. As a backup, there shall be dedicated hardware to detect and disable the system when the user attempts to move more than the configured maximum quantity of motors.

6. All buttons shall fit neatly within each of the cover panel cutouts on the controller.

E. KEY SWITCHES

1. A key switch shall control power to the control system. The key must be in the lock and the key turned to the on position for the motoring system to operate.

2. A separate key is required to turn on the load profiling system. That key must be in the lock and turned to the "ON" position for load profiling to function.

3. When load profiling is turned on the motor shall know the amount of weight that is supposed to be supported by the batten at any location in the path of travel. Should the weight exceed or be reduced below the profiled weight by a preset value, the motor shall stop operation until the fault is cleared.

F. SLACK LINE DETECTOR

1. The slack line detector is located in the Powerhead. When a slack line condition occurs, it shall cease motor movement and result in a fault message on the LCD screen on the controller. Movement in the upward direction shall be possible to clear the fault.

G. E-STOP

1. The E-stop button on the QuickTouch controller shall be a mushroom button with a rear illuminated ring surrounding the button. During normal operation the E-stop button shall be in the out position. An E-stop can be activated via this button by firmly pressing the button in. The button shall latch and immediately cause a class zero stop of all motors in the system. The LCD screen shall report this as an E-stop fault. To continue system operation the E-stop button must be cleared by twisting the button to release the latch. Power to the control station must be cycled off/on to re-initiate the system. This action shall also initiate a self-test of the entire control system and contactors.

2. The illuminated ring around each E-stop button shall be dimmable. The status of the lighted ring shall provide additional information about the state of the system as follows:

   a. Ring at low intensity: no motor moving
   b. Ring at high intensity: motor(s) moving
   c. Ring blinking: system in E-stop condition

3. Up to three remote E-stop stations may be connected to the system. Each additional E-stop station shall operate in the same way as the primary E-stop at the QuickTouch control panel.

H. SYSTEM DIAGNOSTICS

1. Upon energization the control system shall perform an automatic series of diagnostic tests that assure that all system safety functions are working. Should an error in the safety functions be determined, the controller shall report back a fault condition in the LCD display window and shall identify the nature of the fault.

2. Monthly, the system automatically shall perform an additional series of diagnostic tests to determine if there are any problems with any portion of the motor control system safety features. In the event of a problem, the controller shall report back a fault condition in the LCD display window and shall identify the nature of the fault.

3. Eleven months after a system inspection has been performed, the system shall remind the user to schedule full system maintenance/inspection. The reminder shall remain in the system with a count-down calendar until it is turned off by the factory authorized and trained inspector.

4. The installing contractor shall be able to leave contact information within the system. This information shall be displayed at power up and in the event of

severe fault conditions.

I. REMOTE CONTROL PENDANT

1. An optional remote control pendant with 30' long attached cable and plug shall be provided for the system. The remote control must be plugged to the QuickTouch control panel. When the remote control is plugged in the E-stop on the remote is active. Systems requiring "shunt plugs" to bypass an unplugged remote control connector shall not be acceptable.

2. The remote control provides up/down control for those motors that have been preselected at the QuickTouch controller.

J. SYSTEM COMMISSIONING

1. It shall be possible to commission basic functionality of the system without a laptop computer or additional software.

2. A trained installer shall commission the full system via a laptop computer connected via the built-in USB port in the controller. USB connectivity shall not require special USB drivers.

3. Commissioning software shall feature an inspection report generator that allows a step by step inspection of the control system. Upon completion, the system shall generate an inspection report in PDF format..

PART 3 - EXECUTION

3.1 INSTALLATION

A. It shall be the responsibility of the Contractor to receive and store the necessary materials and equipment for installation of the control system. It is the intent of these specifications and plans to include everything required for proper and complete installation and operation of the system. The contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The Contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

C. The Contractor shall install a rigging system in accordance with manufacturer’s approved shop drawings.

D. Coordinate wire guard dimensions, mounting requirements, weight, size, etc. with the wire guard to be provided for the system. Ensure total load weight does not exceed rigging system capacity.

3.2 MANUFACTURER’S SERVICES

A. Upon completion of the formal checkout, the factory engineer shall demonstrate operation and maintenance of the system to the owner’s representative(s). A minimum allowance of eight (8) hours shall be made for programming and training by the factory engineer. Owner will have the option of videotaping all training sessions.

3.3 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions are as shown on the drawings.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.4 INSTALLATION NOTES

A. Install in accordance with manufacturer's instructions.

B. All wiring shall be installed in conduit.

3.5 SYSTEM TRAINING

A. System training shall be performed under provisions of Section 26 05 00.

B. Minimum on-site training times shall be four (4) hours.

END OF SECTION 26 55 62

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:

Referenced Specification Section	**Submittal Item**
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 ≥ 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 Tl 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 contractors 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 <u>not</u> 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 hangar 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 43 - EXTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the products and execution requirements relating to furnishing and installing exterior conduits, sleeves, innerduct, etc. for an exterior cabling plant.

1.2 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

B. Precast Manufacturer (if applicable): Company specializing in precast concrete structures with three (3) years documented experience.

1.3 REFERENCES

A. Section 27 05 00 – Basic Communications Systems Requirements.

B. AASHTO HS-20 - Standard Specification for Highway Bridges.

C. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

D. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.

E. ASTM A48 - Gray Iron Castings.

F. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

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.

B. Manhole submittal (if applicable): Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.

1. Provide product data for manhole accessories.

C. Submit shop drawings and product data under provisions of Section 27 05 00.

D. Submit manufacturer's installation instructions under provisions of Section 27 05 00.

E. Coordination Drawings:

1. Include manholes, hand holes, and conduits 1.5” and larger in coordination files. Include all in--floor and underfloor conduit in coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.5 REGULATORY REQUIREMENTS

A. Equipment and material shall be UL (Underwriters Laboratory) listed and labeled.

PART 2 - PRODUCTS

2.1 OUTSIDE PLANT CONDUIT

A. Rigid Metallic Conduit (RMC) and Fittings:

1. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.

2. Fittings and Conduit Bodies:

a. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.

b. 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.

c. 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.

d. 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.**

e. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

3. Acceptable Manufacturers:

a. Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or pre-approved equal.

B. Rigid Non-Metallic Conduit (RNC) and Fittings:

1. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement.

2. Fittings: NEMA TC3 and TC9, sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.

3. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

4. Acceptable Manufacturers:

a. Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or pre-approved equal.

C. High-Density Polyethylene (HDPE) Conduit:

1. Minimum Size: 2 inches, unless noted otherwise.

2. Acceptable Manufacturers: Carlon, Chevron Phillips Chemical Company, or pre-approved equal.

3. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	< .941
D-1238	Melt Index, g/10 min Condition E	> .55 grams/10 min.
D-638	Tensile Strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B, F 20	96 hrs.
D-790	Flexural Modulus, MPa (psi)	< 80,000
D-746	Brittleness Temperature	-75°C Max

4. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.

5. Fitting and Conduit Bodies:

a. Directional Bore and Plow Type Installation: Electrofusion or universal aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.

b. For All Other Types of Installation: Coupler must provide a watertight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.

c. E-loc type couplings are not acceptable in any situations.

d. Acceptable Manufacturers: ARCON, Carlon, or approved equal.

D. Fittings:

1. Sweeps: Factory manufactured RMC wrapped with 4 mil vinyl tape with a bend radius as follows:

a. Conduit internal diameter of 2" or less is 6 times the internal conduit diameter.

b. Conduit internal diameter of more than 2" is 10 times the internal conduit diameter.

2. End Caps (Plugs): Pre-manufactured and watertight. Tape is not an acceptable end cap or cover.

2.2 TEXTILE INNERDUCT

A. Contractor shall provide and install innerduct in each conduit identified to have copper and fiber optic cable installed.

B. Innerduct shall have an 18 gauge solid copper core tracer wire installed into each cell to allow for detection by industry standard toning equipment.

C. Each innerduct cell shall have a pull tape installed.

D. Acceptable Manufacturers:

1. Maxcell or pre-approved equal.

2.3 HEAVYWALL INNERDUCT

A. General Requirements:

1. Innerduct shall be produced from a suitable thermoplastic polymer conforming to the minimum standards for polyethylene as defined by ASTM.

2. Innerduct shall be high density, high impact resistant, abrasion resistant, and flexible with a low friction factor and light weight.

B. Mechanical Requirements:

1. Innerduct shall have corrugated walls and shall be free from holes, splits, blisters, inclusions, and other performance-affecting imperfections.

2. Innerduct bore shall be free from dimensional non-uniformities, and wall thickness shall be concentric.

C. Dimensions and Tolerances:

1. Innerduct shall conform to IPS dimensions as defined in NEMA TC-2.

SIZE	OD	ID
1”	1.375” (Max.)	1.0” (Min.)
1-1/4”	1.67” (Max.)	1,25” (Min.)
1-1/2”	2.0” (Max.)	1.5” (Min.)

2.4 UNDERGROUND WARNING TAPE

A. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.

B. Overall Thickness: 5 mils (0.125 mm).

C. Foil Core Thickness: 0.35 mil (0.00889 mm).

D. Orange colored tape 3-wide with 1-inch high black letters permanently imprinted with “CAUTION – BURIED COMMUNICATIONS LINE BELOW”. Printing on tape shall be permanent and shall not be damaged by burial operations.

E. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

F. Comply with ANSI Z535.1 through ANSI Z535.5.

PART 3 - EXECUTION

3.1 INSTALLATION - PRECAST CONCRETE MANHOLES

A. Excavate, install base material, and compact base material in accordance with manufacturer’s instructions.

B. Install and seal precast sections in accordance with manufacturer's instructions.

C. Use precast neck and shaft sections to bring manhole entrance to proper elevation.

D. Install manholes plumb.

E. Set the top of each manhole to finished elevation or as indicated on the drawings.

3.2 INSTALLATION - CAST-IN-PLACE CONCRETE MANHOLES

A. Excavate, install base material, and compact base material in accordance with manufacturer’s instructions.

B. Form cast-in-place manholes, inside and outside surfaces, in accordance with the provisions of Division 3.

C. Manhole Shape: As indicated on the drawings.

D. Inside Dimensions: As indicated on the drawings.

E. Wall Thickness: As indicated on the drawings.

F. Formed Window for Duct Entry: As indicated on the drawings.

G. Include 12 inch drain opening and 2 one inch ground rod openings in base section.

H. Cast Cable Pulling Irons in Place Opposite Each Duct Entry Window: As indicated on the drawings.

I. Cast Inserts for Cable Racks in Place: As indicated on the drawings.

3.3 INSTALLATION - MANHOLE ACCESSORIES

A. Install drains in manholes, and connect to 4 inch pipe terminating in 1/3 cu. yd. crushed gravel bed in accordance with provisions of Section 22 10 30.

B. Install ground rod with top protruding 4 inches above manhole floor.

C. Waterproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days minimum, in accordance with provisions of Division 7.

D. Attach cable racks to inserts after manhole is complete.

3.4 INSTALLATION - DUCTBANK

A. Make duct bank installations and penetrations through foundation walls watertight.

B. Top of duct banks shall be a minimum of 24 inches below grade, unless otherwise indicated on drawings.

C. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 3-inch minimum separation between the outer surfaces of the ducts.

D. Transition from non-metallic to galvanized rigid steel conduit where duct banks enter buildings, manholes, and handholes.

E. Where ducts enter structures such as manholes, handholes, pullboxes and buildings, terminate the ducts in suitable end bells.

F. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.

G. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately 1/4 inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand, or gravel have been left in the duct.

H. Plug and seal empty spare ducts entering buildings and structures. Seal watertight all ducts in use entering buildings and structures.

3.5 INSTALLATION – TEXTILE INNERDUCT

A. Provide two (2) 3-cell innerducts per 4" conduit or as recommended by the manufacturer.

B. Install innerduct per manufacturer's guidelines.

C. Cut and tie off innerduct and pull tape inside each communications vault or Entrance Room.

3.6 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. The Contractor shall do all necessary excavating, securing, filling, backfilling, compacting, and restoration in connection with their work.

B. Excavation:

1. Excavations for trenches shall be excavated to proper dimensions to permit installation and inspection of work.

2. Where excavations are carried in error below indicated levels, thoroughly compacted sand-gravel fill, shall be placed in such excess excavations.

3. Excavations shall be protected against frost action and freezing.

4. Care shall be exercised in excavating so as to not damage surrounding structures, equipment, and buried utilities. In no case shall any major structural footing or foundation be undermined.

5. Excavation shall be performed in all ground characteristics, including rock, if encountered. Each bidder shall visit the premises and determine, by actual

observations, borings, or other means, the nature of the soil conditions. The cost of all such inspections, borings, etc., shall be borne by the bidder.

6. In the case where the trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.

7. Where satisfactory bearing soil 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.

8. Mechanical excavation of the trench to line and grade of the conduit, unless otherwise indicated on the drawings.

C. Dewatering:

1. The Contractor shall be responsible for the furnishing, installation, operation and removal of all dewatering pumps and lines necessary to keep the excavation free of water at all times.

D. Underground Obstructions:

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. The Contractor is responsible for obtaining all utility locates for all trades on the project to determine obstructions indicated. The Contractor shall use great care in installing in the vicinity of underground obstruction.

E. Fill and Backfilling:

1. No rubbish or waste material shall be permitted in excavations for trench fill and backfill.

2. The Contractor shall provide the necessary sand for backfilling.

3. Dispose of the excess excavated earth as directed.

4. Soils for backfill shall be suitable for required stability and compaction, clean and free from perishable materials, frozen earth, debris or earth with an exceptionally high void content, and free from stones greater than 4 inches in diameter. Under no circumstances shall water be permitted to rise in unbackfilled trenches after installation has been placed.

5. All trenches shall be backfilled immediately after installation of conduit, unless other protection is directed.

6. All conduit shall be laid on a compacted bed of sand at least 3" deep. Backfill around the conduit with sand, spread in 6" layers, then compact each layer.

7. Use sand for backfill up to grade for all conduit located under building slabs or paved areas. All other conduit shall have sand backfill to 6" above the top of the conduit.

8. The backfilling above the sand shall be placed in uniform layers not exceeding 6" in depth. Each layer shall be placed, then carefully and uniformly tamped, so as to eliminate the possibility of lateral or vertical displacement.

9. Install a warning tape approximately 12 inches below finished grade over all underground duct banks. The identifying warning tape shall be as specified above.

10. Where the fill and backfilling will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as 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 as determined by AASHTO T-99 or ASTM D-698 test.

11. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

3.7 RESTORATION REQUIREMENTS

A. Where soil and sod has been removed, it shall be replaced as soon as possible after backfilling is completed. All areas disturbed by work shall be restored to their original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, or mulching,

END OF SECTION 27 05 43

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 an 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 “quite 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 ("pigtails") 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 (≥ 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 (≤ 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 µm. All optical fibers shall be of the same nominal core diameter and profile.

3. Cladding Diameter: 125 ± 1.0µm.

4. Cladding Non-circularity: ≤ 1%.

5. Core to Cladding Offset: ≤ 0.8 µm.

6. Fiber Coating Diameter:

   a. 245 ± 15µm (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; λ_{ccf}) $\leq$ 1260-nm.

8. Mode Field Diameter: 8.3 to 9.8 m at 1300-nm; 10.5 ± 1.0 µm at 1550-nm.

9. Zero Dispersion Wavelength (λ_0): 1301.5 nm $\leq l_0 \leq$ 1321.5 nm.

10. Zero Dispersion Slope (S_0): $\leq$ 0.092 ps/nm^2*km.

11. Fiber Attenuation (maximum @ 23 ± 5°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 13 43.53 - TELEVISION DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Antennas
B. Broadband RF Surge Protector
C. Indoor Passive Broadband RF Line Equalizer
D. Indoor Passive Broadband RF Channel Elimination Filter
E. Indoor Agile Demodulator
F. Indoor Agile Modulator
G. Indoor Channelized Agile Modulator
H. Indoor Agile Heterodyne Processor
I. Indoor Passive Broadband RF Combiner
J. Indoor Active Broadband RF Combiner
K. Indoor Broadband Fiber Optic Transmitter
L. Indoor Broadband Fiber Optic Coupler
M. Indoor Wall-Mounted Bi-Directional Broadband RF Distribution Amplifier
N. Indoor Rack-Mounted Bi-Directional Broadband RF Distribution Amplifier
O. Outdoor Bi-Directional Broadband RF Distribution Amplifier
P. Indoor Broadband RF Splitter
Q. Outdoor Broadband RF Splitter
R. Indoor Broadband RF Directional Coupler / Tap
S. Outdoor Broadband RF Directional Coupler / Tap
T. Broadband RF Coaxial Cable
U. Coaxial Cable Connectors
V. 75-Ohm F-Type Terminator
W. 75-Ohm KS-Type Terminator

1.2 RELATED WORK

A. Section 26 41 00 - Lightning Protection System
B. Section 27 05 00 - Basic Communications Requirements
C. Section 27 05 26 - Communications Bonding
D. Section 27 13 00 - Backbone Cabling Requirements
E. Section 27 15 00 - Horizontal Cabling Requirements

1.3 REFERENCES

A. Applicable ANSI/SCTE Standards
B. NFPA 70 - National Electrical Code

1.4 SUBMITTALS

A. Submit under provisions of Section 27 05 00.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Show installation details, cable routing, head end device and tap values, and system configuration.

C. Product Data: Provide showing electrical characteristics and connection requirements for each component.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 SYSTEM DESCRIPTION

A. Premise cabling and associated head end equipment for broadband channelized distribution of television signal to information outlet locations.

1.6 PERFORMANCE REQUIREMENTS

A. Installed television distribution system shall provide broadband RF signal at each outlet with the following characteristics:

1. Frequency range: 49 – 860 MHz
2. Signal strength: +6 dB, ± 3dB at all channels distributed
3. Impedance: 75 Ohms

B. Television distribution system shall provide integrated sub-band RF discrete sub-band RF discrete baseband video with audio return functionality to route locally originated audio/video content signals to head end for distribution through system.

C. Local Origination Sources:

1. LaserDisc #1 located in SC-MC-1 Telecom Room 42, distributed on Channel 37
2. Video surveillance camera located at Door 1234, distributed on Channel 1

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 27 05 00.

B. Record actual locations of head end equipment and devices, distribution equipment and devices, outlets, and cable routing.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 27 05 00.

B. Operation Data: Instructions for setting and tuning channels.

C. Maintenance Data: Basic troubleshooting procedures.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section, with minimum three ____ years documented experience, and with service facilities within 100 ____ miles of project.

B. Supplier: Authorized Franchised distributor of specified manufacturer with minimum three ____ years documented experience.

C. Installer: Authorized Franchised installer of specified manufacturer, with service facilities within 100 ____ miles of project.

1.10 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by UL testing firm acceptable to Authority Having Jurisdiction, suitable for purpose specified and indicated.

C. Conform to all applicable Federal Communications Commission requirements and requirements of the cable satellite television service provider.

1.11 MAINTENANCE SERVICE

A. Furnish service and maintenance of television system for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ANTENNAS

A. VHF Antenna

1. Bandwidth: 54 – 88 MHz and 174 – 216 MHz
2. Gain: ≥ 8.2 dBi
3. Impedance: 75 Ohm
4. Return loss: ≥ 12 dB
5. Material: Aluminum
6. Boom length: ≥ 96 inches
7. Element width: ≥ 114 inches
8. Number of elements: ≥ 12
9. Connector: F-type female
10. Provide complete with manufacturer's mounting kit accessory
11. Basis of design: Blonder Tongue BTY-LP-BB

B. UHF Antenna

1. Bandwidth: 470 – 860 MHz
2. Gain: ≥ 10.2 dBi
3. Impedance: 75 Ohm
4. Return loss: ≥ 12 dB
5. Material: Aluminum
6. Boom length: ≥ 24 inches
7. Element width: ≥ 13 inches
8. Number of elements: ≥ 11
9. Connector: F-type female
10. Provide complete with manufacturer's mounting kit accessory
11. Basis of design: Blonder Tongue BTY-UHF-BB

2.2 BROADBAND RF SURGE PROTECTOR

A. Impedance: 75 Ohm
B. Frequency response: 5 – 1000 MHz
C. Insertion loss: ≤ 0.4 dB
D. Surge current protection: ≥ 5,000 AMPS
E. Connectors: F-type female for input and output
F. Integral ground lug terminal
G. Mounting:

1. Integral mounting tabs
2. Wall mounting bracket

H. Basis of design: Nextek PTC-F01

2.3 INDOOR PASSIVE BROADBAND RF LINE EQUALIZER

A. Impedance: 75 Ohm
B. Frequency response: 5 – 860 MHz
C. Insertion loss: ≤ 0.5 dB
D. Return loss: ≥ 18 dB
E. EQ values: 3, 6, 9, 12, 15, and 18 dB models
F. Connectors: F-type female for input and output
G. Integral ground lug terminal
H. Integral mounting tabs
I. Basis of design: Blonder Tongue LE-860

2.4 INDOOR PASSIVE BROADBAND RF CHANNEL ELIMINATION FILTER

A. Impedance: 75 Ohm
B. Overall frequency response: 5 – 750 MHz
C. Overall insertion loss: ≤ 7.5 dB
D. Return loss: ≥ 10 dB
E. Channel suppression level: ≥ 50 dB
F. Adjacent channel insertion loss: ≤ 7 dB
G. Connectors: F-type female for input and output
H. Integral ground lug terminal
I. Rack mounted
J. Basis of design: Blonder Tongue CEF

2.5 INDOOR AGILE DEMODULATOR

A. Input impedance: 75 Ohm
B. Input frequency range: 7 – 860 MHz
C. Video output: Base band video
D. Video output impedance: 75 Ohm
E. Audio output: Balanced line-level audio
F. Audio output impedance: 600 Ohm
G. Connectors:

1. RF input: F-type female
2. Video output: F-type female
3. Audio output: barrier strip screw terminals

H. Supports broadcast, CATV, and UHF channel assignments including HRC and IRC
I. Provides front-panel access to all controls
J. 120 volt AC power supply
K. Integral ground lug terminal
L. Rack mounted
M. Basis of Design: Blonder Tongue AD-1

2.6 INDOOR AGILE MODULATOR

A. Video input: base band video
B. Video input impedance: 75 Ohm
C. Audio input: balanced line-level audio
D. Audio input impedance: 600 Ohm
E. Output impedance: 75 Ohm
F. Output frequency range: 54 – 860 MHz

G. Output level: variable from 50 - 60 dBmv
H. Output return loss: ≥ 10 dB
I. Output carrier to noise: ≥ 63 dB
J. Connectors:

1. Video input: BNC female
2. Audio input: barrier strip screw terminals
3. RF output: F-type female

K. Output channel assignment selectable via front-panel controls
L. Supports broadcast, CATV, and UHF channel assignments including HRC and IRC
M. Provides front-panel access to all controls
N. 120 volt AC power supply
O. Integral ground lug terminal
P. Rack mounted
Q. Basis of design: Blonder Tongue AM-60-860

2.7 INDOOR CHANNELIZED AGILE MODULATOR

A. Video input: base band video
B. Video input impedance: 75 Ohm
C. Audio input: balanced line-level audio
D. Audio input impedance: 10K Ohm
E. Output impedance: 75 Ohm
F. Output frequency range: 54 – 860 MHz
G. Output level: variable from 40 - 60 dBmv
H. Output return loss: ≥ 15 dB
I. Output carrier to noise: ≥ 63 dB
J. Connectors:

1. Video input: F-type female
2. Audio input: RCA female
3. RF output: F-type female

K. Output channel assignment determined by field-replaceable module accessory
L. Supports broadcast, CATV, and UHF channel assignments including HRC and IRC
M. Provides front-panel access to all controls
N. 120 volt AC power supply
O. Integral ground lug terminal
P. Rack mounted
Q. Basis of design: Blonder Tongue MAVM-60-861

2.8 INDOOR AGILE HETERODYNE PROCESSOR

A. Input: RF video
B. Input impedance: 75 Ohm
C. Input frequency range: 5 – 806 MHz
D. Output: RF video
E. Output impedance: 75 Ohm
F. Output frequency range: 54 – 550 MHz
G. Output level: variable from 50 – 60 dBmv
H. Output return loss: ≥ 10 dB
I. Output carrier to noise: ≥ 63 dB
J. Connectors: F-type female for input and output
K. Input and output channel assignments selectable via front-panel controls
L. Supports broadcast, CATV, and UHF channel assignments including HRC and IRC

M. Provides front-panel access to all controls
N. 120 volt AC power supply
O. Integral ground lug terminal
P. Rack mounted
Q. Basis of design: Blonder Tongue AP-40-550B

2.9 INDOOR PASSIVE BROADBAND RF COMBINER

A. Impedance: 75 Ohm
B. Frequency range: 5 – 1000 MHz
C. Insertion Loss:

1. 8-port model: ≤ 13 dB
2. 12-port model: ≤ 18 dB
3. 16-port model: ≤ 26 dB
4. 24-port model: ≤ 21 dB
5. 32-port model: ≤ 20 dB

D. Isolation between ports: ≥ 25 dB
E. Flatness: ≤ +/- 0.4 dB
F. Return loss: ≥ 14 dB
G. Connectors: F-type female for input and output
H. Front-panel test port
I. Integral ground lug terminal
J. Rack mounted
K. Basis of design: Blonder Tongue OC

2.10 INDOOR ACTIVE BROADBAND RF COMBINER

A. Impedance: 75 Ohm
B. Frequency range: 50 – 450 MHz
C. Unit gain: variable from 8 – 12 dB
D. Maximum output: ≥ 50 dBmv
E. Flatness: ≤ +/- 0.25 dB
F. Return loss: ≥ 16 dB
G. Connectors: F-type female for input and output
H. Front-panel test port
I. Provides front-panel access to all controls
J. 120 volt AC power supply
K. Integral ground lug terminal
L. Rack mounted
M. Basis of design: Blonder Tongue OCA

2.11 INDOOR BROADBAND FIBER OPTIC TRANSMITTER

A. Frequency range: 50 – 860 MHz
B. Input impedance: 75 Ohm
C. Input return loss: ≥ 16 dB
D. Optical output wavelength: 1310nm
E. Output power: 6 dB 8 dB 10 dB 12 dB 14 dB
F. CNR: ≥ 50 dB
G. Connectors:

1. RF input: F-type female coaxial copper
2. Optical output: FC/APC singlemode fiber optic

H. Provides front-panel access to all controls
I. 120 volt AC power supply
J. Integral ground lug terminal
K. Rack mounted
L. Basis of design: Blonder Tongue FIBT-S3A-810B FIBT-S3A-812B FIBT-S3A-814B FIBT-S3A-816B FIBT-S3A-818B

2.12 INDOOR BROADBAND FIBER OPTIC COUPLER

A. Optical wavelength compatibility: 1310nm and 1550 nm
B. Number of inputs: 1
C. Number of outputs: 2 3 4 6 8 16
D. Insertion loss: ≤ 12.6 dB
E. Uniformity: ≥ 0.7 dB
F. Directivity: ≥ 50 dB
G. Connectors: FC/APC singlemode fiber optic for input and outputs
H. Rack mounted
I. Basis of design: Blonder Tongue FOC-102U-FA FOC-104U-FA FOC-108U-FA FOC-116U-FA

2.13 INDOOR WALL-MOUNTED BI-DIRECTIONAL BROADBAND RF DISTRIBUTION AMPLIFIER

A. Impedance: 75 Ohm
B. Frequency response

1. Forward: 54 – 860 MHz
2. Return: 5 – 36 MHz

C. Return loss

1. Input: ≥ 16 dB
2. Output: ≥ 16 dB

D. Gain control range: ≥ 10 dB
E. Maximum output: + 40 dBmV, +/- 1.5 dB flatness
F. Noise at maximum output: ≤ 8.5 dB
G. Connectors: F-type female for input and output
H. Field-configurable active or passive return
I. Accepts plug-in equalizer and attenuator accessories
J. 120 volt AC power supply
K. Integral ground lug terminal
L. Basis of design: Blonder Tongue BIDA 86A-43P

2.14 INDOOR RACK-MOUNTED BI-DIRECTIONAL BROADBAND RF DISTRIBUTION AMPLIFIER

A. Impedance: 75 Ohm
B. Frequency response

1. Forward: 54 – 860 MHz
2. Return: 5 – 36 MHz

C. Return loss

1. Input: ≥ 14 dB
2. Output: ≥ 14 dB

D. Gain control range: ≥ 10 dB
E. Maximum output: + 40 dBmV, +/- 1.5 dB flatness
F. Noise at maximum output: ≤ 8.5 dB
G. Connectors: F-type female for input and output
H. Field-configurable active or passive return
I. Accepts plug-in equalizer and attenuator accessories
J. Provides front-panel access to all controls
K. Test port on front panel
L. 120 volt AC power supply
M. Integral ground lug terminal
N. Basis of design: Blonder Tongue RMDA 86A-30

2.15 OUTDOOR BI-DIRECTIONAL BROADBAND RF DISTRIBUTION AMPLIFIER

A. Impedance: 75 Ohm
B. Frequency response

1. Forward: 54 – 860 MHz
2. Return: 5 – 42 MHz

C. Return loss

1. Input: ≥ 16 dB
2. Output: ≥ 16 dB

D. Gain control range: ≥ 5 dB
E. Slope control range: ≥ 8 dB
F. Maximum output: + 44 dBmV, +/- 1.5 dB flatness
G. Noise at maximum output: ≤ 9 dB
H. Connectors: KS-type female for input and output
I. Field-configurable active or passive return
J. Accepts plug-in equalizer and attenuator accessories
K. Equipped with test port
L. Remote powered via power connector or signal input / output connectors
M. Integral ground lug terminal
N. Gasketed weatherproof housing
O. Basis of design: Blonder Tongue BODA 86A-40P

2.16 INDOOR WALL-MOUNTED BROADBAND RF DISTRIBUTION AMPLIFIER

A. Input wavelength: 1310 / 1550 nm
B. Input range: -6 dBm to +3 dBm
C. Output Impedance: 75 Ohm
D. Frequency response: 47 – 860 MHz
E. Return loss

1. Input: ≥ 14 dB
2. Output: ≥ 14 dB

F. Gain control range: ≥ 10 dB
G. Maximum output: + 42 dBmV, +/- 0.75 dB flatness
H. Slope control range: ≥ 10 dB
I. Connectors:

1. Input: FC/APC singlemode fiber optic
2. Output: F-type female coaxial copper

J. Accepts plug-in attenuator accessories
K. Equipped with test port
L. 120 volt AC power supply
M. Integral ground lug terminal
N. Basis of design: Blonder Tongue FRDA-S4A-860-FA

2.17 INDOOR RACK-MOUNTED BROADBAND RF DISTRIBUTION AMPLIFIER

A. Input wavelength: 1310 / 1550 nm
B. Input range: -6 dBm to +3 dBm
C. Output Impedance: 75 Ohm
D. Frequency response: 54 – 860 MHz
E. Return loss

1. Input: ≥ 14 dB
2. Output: ≥ 14 dB

F. Gain control range: ≥ 10 dB
G. Maximum output: +42 dBmV, +/- 0.75 dB flatness
H. Slope control range: ≥ 8 dB
I. Connectors:

1. Input: FC/APC singlemode fiber optic
2. Output: F-type female coaxial copper

J. Accepts plug-in attenuator accessories
K. Provides front-panel access to all controls
L. Test port on front panel
M. 120 volt AC power supply
N. Integral ground lug terminal
O. Basis of design: Blonder Tongue FRRA-S4A-860-43P

2.18 INDOOR BROADBAND RF SPLITTER

A. Impedance: 75 Ohm
B. Frequency response: 5 – 1000 MHz
C. Number of output ports: 2, 3, 4, 6, and 8 port models
D. Insertion loss (maximum at 1000 MHz):

1. 2-port: 4.2 dB
2. 3-port: 8 dB
3. 4-port: 8.1 dB
4. 6-port: 11.3 dB
5. 8-port: 12.2 dB

E. Return loss: ≥ 18 dB at 1000 MHz
F. Isolation between outputs: ≥ 21 dB
G. Connectors: F-type female for input and outputs
H. L-style configuration with connectors oriented perpendicular to backplane of device
I. Integral ground lug terminal
J. Integral mounting tabs
K. Basis of design: Blonder Tongue SCVS

2.19 OUTDOOR BROADBAND RF SPLITTER

A. Impedance: 75 Ohm
B. Frequency response: 5 – 1000 MHz
C. Number of output ports: 2 and 3 port models
D. Insertion loss (maximum at 1000 MHz):

1. 2-port: 5.2 dB
2. 3-port: 9.2 dB

E. Return loss: ≥ 18 dB at 1000 MHz
F. Isolation between outputs: ≥ 18 dB
G. Connectors: KS-type female for input and outputs
H. Power-passing capability
I. Integral ground lug terminal
J. Integral mounting hardware
K. Gasketed weatherproof housing
L. Basis of design: Blonder Tongue TLS-1000

2.20 INDOOR BROADBAND RF DIRECTIONAL COUPLER / TAP

A. Impedance: 75 Ohm
B. Frequency response: 5 – 1000 MHz
C. Number of output ports: 2, 4, and 8 port models
D. Tap values:

1. 2-port: 8, 11, 14, 17, 20, 23, 26, 29, and 32 dB models
2. 4-port: 11, 14, 17, 20, 23, 26, 29, 32, and 35 dB models
3. 8-port: 14, 17, 20, 23, 26, 29, 32, and 35 dB models

E. Insertion loss, input to through output (maximum at 1000 MHz):

1. 2-port models
   a. 8 dB model: 3.5 dB
   b. 11 dB model: 3.0 dB
   c. 14 dB model: 2.2 dB
   d. 17 dB model: 1.8 dB
   e. 20 dB model: 1.2 dB
   f. 23 dB model: 1.2 dB
   g. 26 dB model: 1.2 dB
   h. 29 dB model: 1.2 dB
   i. 32 dB model: 1.2 dB

2. 4-port model
   a. 11 dB model: 4.4 dB
   b. 14 dB model: 2.5 dB
   c. 17 dB model: 2.0 dB
   d. 20 dB model: 1.4 dB
   e. 23 dB model: 1.2 dB
   f. 26 dB model: 1.0 dB
   g. 29 dB model: 1.0 dB
   h. 32 dB model: 1.0 dB
   i. 35 dB model: 1.0 dB

3. 8-port model
    a. 14 dB model: 4.5 dB
    b. 17 dB model: 2.5 dB
    c. 20 dB model: 2.0 dB
    d. 23 dB model: 1.4 dB
    e. 26 dB model: 1.2 dB
    f. 29 dB model: 1.0 dB
    g. 32 dB model: 1.0 dB
    h. 35 dB model: 1.0 dB

F. Return loss: ≥ 16 dB at 1000 MHz
G. Isolation between tap outputs: ≥ 22 dB
H. Connectors: F-type female for input and outputs
I. L-style configuration with tap output connectors oriented perpendicular to backplane of device
J. Integral ground lug terminal
K. Integral mounting tabs
L. Basis of design: Blonder Tongue SRT

2.21 OUTDOOR BROADBAND RF DIRECTIONAL COUPLER / TAP

A. Impedance: 75 Ohm
B. Frequency response: 5 – 1000 MHz
C. Number of output ports: 2, 4, and 8 port models
D. Tap values:

1. 2-port: 8, 11, 14, 17, 20, 23, 26, 29, 32, and 35 dB models
2. 4-port: 11, 14, 17, 20, 23, 26, 29, 32, and 35 dB models
3. 8-port: 14, 17, 20, 23, 26, 29, 32, and 35 dB models

E. Insertion loss, input to through output (maximum at 1000 MHz):

1. 2-port models
    a. 8 dB model: 4.8 dB
    b. 11 dB model: 3.8 dB
    c. 14 dB model: 2.4 dB
    d. 17 dB model: 2.2 dB
    e. 20 dB model: 1.7 dB
    f. 23 dB model: 1.7 dB
    g. 26 dB model: 1.5 dB
    h. 29 dB model: 1.5 dB
    i. 32 dB model: 1.5 dB
    j. 35 dB model: 1.5 dB

2. 4-port model
    a. 11 dB model: 4.8 dB
    b. 14 dB model: 3.7 dB
    c. 17 dB model: 2.2 dB
    d. 20 dB model: 2.0 dB
    e. 23 dB model: 1.8 dB
    f. 26 dB model: 1.5 dB
    g. 29 dB model: 1.5 dB
    h. 32 dB model: 1.5 dB
    i. 35 dB model: 1.5 dB

3. 8-port model
    a. 14 dB model: 4.9 dB
    b. 17 dB model: 3.2 dB
    c. 20 dB model: 2.6 dB
    d. 23 dB model: 2.2 dB
    e. 26 dB model: 1.5 dB
    f. 29 dB model: 1.5 dB
    g. 32 dB model: 1.5 dB
    h. 35 dB model: 1.5 dB

F. Return loss: ≥ 17 dB at 1000 MHz
G. Isolation between tap outputs: ≥ 23 dB
H. Connectors: KS-type female for input and F-type female for outputs
I. L-style configuration with tap output connectors oriented perpendicular to backplane of device
J. Power-passing capability
K. Integral ground lug terminal
L. Integral mounting hardware
M. Gasketed weatherproof housing
N. Basis of design: Blonder Tongue DMT-1000

2.22 BROADBAND RF COAXIAL CABLE

A. Refer to Section 27 15 00 for RG-6 cable requirements
B. Refer to Section 27 15 00 for RG-11 cable requirements
C. Refer to Section 27 13 00 for .500 hardline cable requirements

2.23 COAXIAL CABLE CONNECTORS

A. RG-6 quad shield coaxial cable connector:

1. F-type male connector
2. Free-spinning sealed nut design
3. 360° radial compression
4. Shielding effectiveness ≥ -80dB
5. SCTE-compliant seal to cable jacket
6. Basis of design: Corning Gilbert GF-UR-6

B. RG-11 quad shield coaxial cable connector:

1. F-type male connector
2. Free-spinning sealed nut design
3. 360° radial compression
4. Shielding effectiveness ≥ -80dB
5. Return Loss ≥ 30 dB
6. Insertion Loss ≤ 0.08 dB
7. SCTE-compliant seal to cable jacket
8. Basis of design: Corning Gilbert GAF-UR-11

C. 0.500 Hardline coaxial cable connector:

1. F-type male connector for hardline coaxial cable
2. Coated aluminum connector body
3. Brass contact pins
4. Shielding effectiveness ≥ -105dB
5. Return Loss ≥ 30 dB

6. Insertion Loss ≤ 0.2 dB
7. SCTE-compliant seal to cable jacket
8. Basis of design: Corning Gilbert GRS-500-AFM-DU-0

D. 0.500 Hardline coaxial cable connector:

1. KS-type male connector for hardline coaxial cable
2. Coated aluminum connector body
3. Brass contact pins
4. Shielding effectiveness ≥ -130dB
5. Return Loss ≥ 30 dB
6. Insertion Loss ≤ 0.15 dB
7. SCTE-compliant seal to cable jacket
8. Basis of design: Corning Gilbert GRS-500-CH-DU-03-T

2.24 75-OHM F-TYPE TERMINATOR

A. Impedance: 75 Ohm
B. Connector: F-type male
C. Basis of design: Blonder Tongue BTF-TP

2.25 75-OHM KS-TYPE TERMINATOR

A. Impedance: 75 Ohm
B. Connector: KS-type male
C. Basis of design: Blonder Tongue DMT-TP

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all equipment in accordance with manufacturer's recommendations.

B. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tools recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.

C. Connect television service to distribution equipment in accordance with the cable satellite television service provider's recommendations. Contractor shall coordinate all requirements with the television service provider prior to cable and equipment installation.

D. Properly ground all television system components and wiring. Bond outdoor components to lightning protection system as close to the point of entrance as possible.

E. All fittings on and connections to equipment installed outdoors shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against weather and moisture ingress. Applied heat shrink tubing shall overlap cable's outer jacket a minimum of 4 inches past connector and be installed in accordance with manufacturer's instructions.

F. All unused ports, including test ports on equipment, shall be terminated with a non-locking 75-Ohm terminator cap.

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 that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

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 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Section 27 05 00.

B. Supervise final adjustments and tuning of system.

3.4 ADJUSTING

A. Adjust work under provisions of Section 27 05 00.

B. Adjust work under supervision of manufacturer's field service personnel.

C. Adjust each antenna using field strength meter to orient it for maximum signal reception on all channels maximum signal reception of Owner-specified channels.

D. Adjust amplifier gain, slope, and other system adjustments to achieve specified output levels at each outlet.

3.5 TESTING

A. Test installed cable under provisions of Section 27 17 10.

B. Measure delivered signal at each outlet to verify specified output levels and signal quality at each outlet.

C. Document measured signal at each outlet and include in test data submitted at completion of project under provisions of Section 27 17 10.

3.6 SYSTEM COMMISSIONING:

A. The Contractor shall notify the Architect/Engineer and Owner prior to conducting final system commissioning.

B. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 09 00 - General Commissioning for additional information.

C. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 09 00 - General Commissioning for system verification tests and commissioning requirements.

D. Contractor shall demonstrate system performance of all equipment and adjust settings as directed by the Architect/Engineer and/or Owner.

1. All system settings, options, and parameters shall be simulated and tested by the Contractor as part of the commissioning process.

3.7 DEMONSTRATION

A. Provide systems demonstration under provisions of Section 27 05 00.

B. Demonstrate color television operation and specified signal level at two _____ outlets on each floor selected by the Owner.

3.8 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. User Manual: A course detailing the system functions and operations that a daily user will encounter.

2. Technical User: Provide configuration training on all aspects of the system(s), including equipment and software.

3. Maintenance User: Provide training on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning, and filter changing.

C. Minimum on-site training times shall be:

1. User Manual: One _____ day.

2. Technical user: One _____ day.

3. Maintenance user: One _____ day.

4. The Contractor shall include in his/her bid one (1) additional day of training each quarter for the 12-month period of the project warranty. The Contractor shall return to the site for additional follow-up training during this period.

END OF SECTION 27 13 43.53

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:

Electrical Value (1 - 250 MHz)	**Over Standard**
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:

Test Procedure	Maximum Attenuation Change
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:

Test Procedure	Maximum Attenuation Change
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: ≥ 82%.

3. Velocity of propagation: ≥ 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: ≥ 82%.

3. Velocity of propagation: ≥ 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 ± 30 nm. Singlemode optical fibers (if applicable) shall be tested at 1300 ± 20 nm.7

(2) Attenuation of optical fibers shall not exceed the values calculated as follows:

Attenuation (max.) = 2*C+L*F+S 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 27 41 00 - PROFESSIONAL AUDIO/VIDEO SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. System Components
B. Audio Connectors
C. Audio Cabling
D. Video Connectors
E. Analog Video Cabling
F. Digital Video Cabling
G. Transmission Connectors
H. Transmission Cabling
I. Control Cabling
J. Horizontal Copper and Fiber Cabling and Connectors

1.2 RELATED WORK

A. Section 26 05 33 - Conduit
B. Section 26 05 13 - Wire and Cable
C. Section 27 05 00 - Basic Communications Requirements
D. Section 27 05 26 - Communications Bonding
E. Section 26 05 03 Through Penetration Firestopping
F. Section 27 11 00 - Communication Equipment Rooms
G. Section 27 05 28 - Interior Communications Pathway
H. Section 27 15 00 - Horizontal Cabling Requirements

1.3 QUALITY ASSURANCE

A. Manufacturer: The manufacturer of equipment shall have a complete service organization for all products in the manufacturer's line.

B. Integrator/Dealer: The Contractor must be a factory-authorized and certified integrator/dealer specializing in the selected manufacturer's products, with demonstrated prior experience with the selected manufacturer's system installation and programming.

C. The Contractor shall have an InfoComm International (ICIA) Certified Technology Specialist (CTS) on staff and supervising the project. This service shall not be subcontracted.

D. The Contractor(s) shall provide a résumé of prior experience in similar types and scales of projects, and other projects that may have been completed with the client. The résumé shall include the project name, square footage, budget, system descriptions, and references with email addresses and phone numbers.

E. Control System Dealer: The media control system shall be provided, terminated, installed, and programmed by a factory-authorized and certified dealer and integrator in good standing with the manufacturer. The dealer shall have direct purchasing and support authority. These services shall not be subcontracted.

F. Control System Programmer: The media control system shall be programmed by a factory-trained and certified programmer.

1. Should the installer of the system not employ a factory-trained and certified programmer, a representative from the equipment manufacturer or certified independent programmer shall be retained for programming services. The Contractor shall be responsible for payment of his/her services until the job is complete and signed off.

2. The programmer providing programming and configuration of the systems shall be a factory-certified Extron Control Specialist (ECS) on staff.

G. Audio System Programmer: All digital sound processing equipment (DSP) used on the project shall be setup, programmed and calibrated by a factory-trained and certified technician.

H. Video System Programmer: All video distribution and processing used on the project shall be setup, programmed and calibrated by a factory-trained and certified technician.

I. The Contractor shall have acquired and maintained all certifications for a minimum of one (1) month prior to the posted bid date of this project.

J. Servicing Contractor: The installer must be factory certified to provide service on the installed manufacturer's equipment and must have local service representatives within a 100 mile radius of the project site.

1.4 REFERENCES

A. ADA - Americans with Disabilities Act

B. ADAAG - Americans with Disability Accessibility Guidelines

C. ANSI - American National Standards Institute

D. ANSI/InfoComm 1M-2009 - Audio Coverage Uniformity in Enclosed Listener Areas

E. ANSI/InfoComm 2M-2010 - Standard Guide for Audiovisual Systems Design and Coordination Processes

F. BICSI/InfoComm - AV Design Reference Manual (AVDRM)

G. IBC - International Building Code

H. IEC - International Electrotechnical Commission

I. InfoComm – Dashboard for Controls

J. NFPA 70 - National Electrical Code (NEC)

K. UL 813 - Commercial Audio Equipment

L. UL 1419 – Professional Video and Audio Equipment

M. UL 1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

N. UL 1492 – Audio/Video Products and Accessories

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 27 05 00.

B. Initial Submittals: To be submitted after the project is awarded but before equipment is purchased and installed.

1. Contractor(s) résumé of qualifications.

2. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

   a. Compliance with each requirement of these documents.
   b. All component options and accessories specific to this project.
   c. Electrical power consumption rating and voltage.
   d. Wiring requirements.
   e. Pre-terminated cable distances and requirements identified by each room where required.

3. Manufacturer Certifications:

   a. All certifications shall be current and valid. Any certificate with expired dates will not be accepted.
   b. Control system authorized dealer certification and dealer #.
   c. Control system certified programmer certification(s).
   d. Audio system DSP dealer certification and dealer #.
   e. Audio system DSP programmer certification.
   f. Professional audio components dealer certification(s) and dealer #.
   g. Video system dealer certification(s) and dealer #.
   h. All other applicable dealer, installation and programming certifications.

4. If an alternate manufacturer(s) is submitted, the equivalent certifications to the basis of design manufacturer(s) shall be required and submitted.

5. Audio and video testing and calibration equipment and software.

6. All applicable Microsoft certifications.

7. All applicable InfoComm International (ICIA) certifications.

8. Available wireless microphone frequencies within a 50 mile range based on the submitted system(s) and coordinated with the quantity of channels.

9. Alternate System Drawings: If an approved alternate manufacturer is submitted, the Contractor shall provide project-specific system CAD drawings as follows:

   a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as "typical" of the device shown.

C. Later Submittals: To be submitted after all initial submittals have been approved but before equipment is installed, configured, and programmed.

1. System Drawings: Project-specific system CAD drawings shall be provided as follows:

a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as “typical” of the device shown.

D. The Contractor **shall** submit graphic or emulated representations of the control system touch panels for each unique space and layout prior to purchase, installation and programming for review and comment by the Architect/Engineer and Owner. These shall show and describe the intended programming/macro control features and functions of each button/icon for all pages.

E. The Contractor shall submit graphic or emulated representations of the control system keypads for each unique space and layout prior to purchase, installation and programming for review and comment by the Architect/Engineer and Owner. These shall show and describe the intended programming/macro control features and functions of each button/knob.

F. The Contractor shall submit the actual DSP audio processor files prior to purchase, installation, and programming for review and comment by the Architect/Engineer and Owner.

G. The Contractor shall submit the actual DSP audio processor control software files prior to programming and project completion for review and comment by the Architect/Engineer and Owner.

H. The Contractor shall submit the number of IP addresses, VLANS, and subnetworks that will be required from the Owner’s Information Systems Department.

I. Submit meeting agenda for planning/programming meetings as required in Part 3 of this specification.

J. Submit detailed description of Owner training to be conducted at project end, including specific training times.

K. Provide rack drawing(s) showing the mounting of equipment in each rack or cabinet on the project.

L. A console and equipment rack plan shall be provided showing console and rack elevations and dimensions in plan view. The plan shall include equipment layout within the console and rack.

M. Submit the engineered and coordinated rigging solution(s) for the following items:

1. Surface-mounted and/or flown loudspeakers.

2. Ceiling-mounted and/or flown projectors, including distance from the screen, height to the lens, and the angle of the projector based on actual field conditions.

3. Projection screens, including height from the finished floor and black screen masking from finished ceiling.

N. If an alternate loudspeaker design is going to be utilized, the Contractor shall submit the following sets of calculations:

1. EASE Calculations:

a. All calculations shall be completed at a minimum patch size resolution of 1.00ft at 1/3 octave, 35ms split time, and shown with Summed Interference and Map with Shadow turned on. The calculations shall be submitted electronically as EASE OpenGL (*.egl) files. The Contractor shall also provide a copy of the latest version of the EASE GLL viewer to view the electronic EASE files.

b. Direct SPL at125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz, and Broadband sum.

c. Total SPL at 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz, and Broadband sum

d. Articulation Loss of Consonants (ALCons).

e. Calculated Speech Transmissible Index (STI) using the Modulation Transfer Index (MTI) with noise levels.

f. Calculated Rapid Speech Transmissible Index (RaSTI) with noise levels.

g. Reverb Times (RT60) from 100 Hz to 10000 Hz.

h. The Contractor shall use the latest version of EASE.

i. The Contractor shall refer to the architectural drawings and specifications for room geometry, room dimensions and surface finishes.

j. The Contractor shall use a listener sitting height of four (4) feet for rooms where the primary function will be sitting. The Contractor shall utilize a listener standing height of five feet three inches (5.25') for rooms where the primary function will be standing.

k. The Contractor shall use a standard indoor temperature of 68°F, 60% humidity and a standard pressure of 29.8 Hg, unless more specific data is available.

l. The Contractor shall submit packed electronic EASE files or an EASE generated list of materials and room data for review and approval by the Architect/Engineer.

2. Manual Calculations:

a. Equivalent Acoustic Distance (EAD).
b. Distance from talker at primary lectern to the furthest listener (D_0).
c. Distance from talker at primary lectern to the microphone (D_S).
d. Distance from primary microphone to the loudspeaker (D_1).
e. Distance from loudspeaker to the furthest listener (D_2).
f. Critical distance (distance from a source where the direct and reverberant sound are equal) (D_C).

g. Calculated Rapid Speech Transmissible Index (RaSTI) at 1000 Hz.
h. Needed Acoustic Gain (NAG).
i. Potential Acoustic Gain (PAG).
j. Electrical Power Required (EPR).
k. Directivity of loudspeakers (Q).

O. The Architect/Engineer has completed an EASE model of the project using EASE Jr. Version 4.3.#. The successful Contractor shall contact the Architect/Engineer for an Electronic File Transmittal Release Form to receive the electronic EASE files to complete the required calculations, choose alternate loudspeaker models, and to assist in aiming and positioning the loudspeakers.

P. Quality Assurance:

1. Provide system checkout and commissioning procedure to be performed at acceptance.

Q. Discontinued Products and New Model Releases:

1. For each product, the Contractor shall submit (in addition to the specified product) a product cutsheet if the specified product has been replaced, improved upon, phased out or otherwise upgraded at the time of shop drawing submittal.

a. The intent of this requirement is for the Contractor to submit only direct replacements for the specified products. A direct replacement shall be defined as a product of newer release that has equal or greater capabilities, which is available for not more than a 10% premium over the specified product's bid unit cost.

b. It is not the intent of this requirement for the Contractor to submit new products or other product options that significantly differ in capability and/or cost from the specified product.

R. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.6 SYSTEM DESCRIPTION

A. This specification section describes the furnishing, installation, commissioning and programming of audio/video components and systems.

B. The Fieldhouse Audio/Video System will provide for multiple presets to accommodate the different set ups for the system, from competition mode, practice mode, instruction mode and any other optional set up the school may require. The contractor shall have a meeting with the users prior to programming to allow for their input in all the required presets needed. The video system shall provide for the ability to display the cameras on owner furnished video projectors and screens, as well as streaming live video.

C. The Presentation Rooms shall be two separate Audio/Video systems, which will be able to be combined for one large system. The video projectors will be owner furnished and contractor installed. The system will provide for remote wall inputs with HDMI and VGA with audio. Wall mounted wired touch screens will be provided for room control and combining. The room shall be able to be combined from either touch screen.

D. The Tutoring room Audio/Video system will allow for display of HDMI and VGA with audio on the owner furnished, contractor installed video projector. The system will have a wireless collaboration gateway. A remote control system with wall mounted touch screen will be provided for all room and equipment controls.

E. Performance Statement: This specification section and the accompanying Contract Documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made and every feature and function that must be programmed and configured. Based on the equipment constraints 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.

F. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment and other miscellaneous equipment required for proper system installation and operation shall be provided by the Contractor.

G. This document describes the major programming features and functions of the system. All additional programming, configuration and integration required for proper system installation and operation shall be provided by the Contractor.

H. When a specific manufacturer is not provided in this document for minor pieces of equipment, the Contractor shall provide only those materials considered to be of the same industry commercial and professional quality level as the major equipment manufacturers.

1.7 LICENSING REQUIREMENTS

A. All user licenses required for system operation shall be included in the Contractor's bid. User licenses shall include, but not be limited to, server and workstation software and any other licensing that is required by the manufacturer for operation of any system component.

1. Licenses shall be provided on a one-to-one basis. One license shall be provided for each server, workstation, and device requiring a license. In the event the manufacturer requires the purchase of a block of licenses, the minimum standard licensing package to support all devices with 10% growth shall be provided.

1.8 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide all applicable certifications.

C. Provide final system block diagram showing any deviations from shop drawing submittal.

D. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.

E. Provide schedules documenting all terminal block wiring, including cable numbers.

F. Warranty: Submit written warranty and complete all Owner registration forms.

G. Complete all operation and maintenance manuals as described below.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 27 05 00.

B. Manuals: Final copies of the manuals shall be delivered after completing the installation. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the Contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation shall include all modifications made during installation, checkout, and acceptance. Manuals shall be submitted in electronic format. The manuals shall consist of the following:

1. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.

2. Hardware Manual: The manual shall describe all equipment furnished including:

   a. General description and specifications.
   b. Installation and checkout procedures.
   c. Equipment layout and electrical schematics to the component level.
   d. System layout drawings and schematics.
   e. Alignment and calibration procedures.
   f. Manufacturers repair parts list indicating sources of supply.

3. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

   a. Definition of terms and functions.
   b. System use and application software.
   c. Initializations, startup, and shutdown.
   d. Reports generation.
   e. Details on forms customization and field parameters.

4. Operator's Manual: The operators manual shall fully explain all procedures and instructions for the operation of the system including:

   a. Computers and peripherals.
   b. System startup and shutdown procedures.
   c. Use of system, command, and applications software.
   d. Recovery and restart procedures.
   e. Use of report generator and generation of reports.
   f. Data entry.
   g. Operator commands.
   h. Alarm messages and reprinting formats.
   i. System permissions functions and requirements.

5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

C. Audio Calibration Data: Provide documentation on all EQ settings, crossover points, limiter settings, gate settings and all other applicable settings.

D. Intellectual Property Ownership: Provide all uncompiled source code and DSP programming for all systems and spaces as described in Part 3 of this specification section.

1.10 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.

1. Inspections: The Contractor shall perform two (2) minor inspections at even intervals (or more often if required by the manufacturer), and two (2) major inspections offset equally between the minor inspections.

2. Minor Inspections: These inspections shall include:

a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.

b. Mechanical adjustments if required on any mechanical or electromechanical devices.

3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:

a. Clean all equipment, including filters, interior and exterior surfaces.

b. Perform diagnostics on all equipment.

c. Check, test, and calibrate (if required) any sensors or other equipment that contain settings.

d. Check zoom and focus of all projectors.

e. Run all system software diagnostics and correct all diagnosed problems.

C. Operation: Upon the performance of any scheduled adjustments or repairs, Contractor shall verify operation of the systems.

D. Emergency Service: The Owner will initiate service calls when the systems are not functioning properly. Qualified personnel shall be available to provide service within the distance defined within this specification section. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Service personnel shall be at site within 24 hours after receiving a request for service.

E. Records and Logs: The Contractor shall keep records and logs of each task completed under warranty. The log shall contain all initial settings at substantial completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the systems.

F. Work Requests: The Contractor shall separately record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within five (5) business days after work is accomplished.

G. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

H. Software: The Contractor shall provide all software and firmware updates during the period of the warranty and verify operation of the system upon installation. These updates shall be accomplished in a timely manner, fully coordinated with system operators, shall include training for the new changes/features, and shall be incorporated into the operations and maintenance manuals, and software documentation.

I. Refer to the individual product sections for further warranty requirements of individual system components.

1.11 ANNUAL SERVICE CONTRACT

A. Provide annual cost for extended service and maintenance warranty after the first year for the audio/video systems according to the following terms:

1. The term of the warranty shall begin on the system acceptance date and shall continue for one (1) year. The extended service and maintenance warranty may begin following this first year if accepted by the Owner. The term may be automatically renewed for successive one-year periods unless canceled by the Owner. The service and maintenance agreement shall include the following basic services to the Owner, including all necessary parts, labor and service equipment:

a. Repair or replace any equipment item that fails to perform as initially installed, as specified, or as determined per the manufacturer's performance criteria.

b. Perform semi-annual preventive maintenance on the equipment. This preventive maintenance shall include, but is not limited to, cleaning, realignment, filter cleaning and replacement, inspection, re-calibration, and testing of devices. The Owner shall receive a written report of these inspections that identifies the device's status and, if required, a list of all necessary repairs or replacements.

c. Provide software and firmware maintenance on the system. Contractor shall install and configure any software and firmware updates that the manufacturer provides at no cost. Any additional software or firmware options, updates, or enhancements purchased by the Owner shall be installed. The Contractor shall not be responsible for the purchase of additional software packages or the maintenance of Owner data.

2. The Contractor shall be compensated for any repairs or maintenance provided as a result of Owner abuse, misuse, intentional damage, accidental damage, or power fluctuations exceeding specified equipment tolerances.

3. System defects or failures shall be corrected within four (4) hours on the same business day if the Owner makes a service request before 11:00 am, or before 12:00 noon the next business day if the Owner makes the request after 11:00 am. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Contractor's services shall be performed in a good and workmanlike manner and remain free from defects for a period of one (1) year.

B. Provide complete terms and conditions of warranty and service.

C. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Refer to the project drawings for basis of design system components. Equivalent products shall meet or exceed all requirements defined on the project drawings. The following product information represents the minimum additional requirements for equivalent products:

B. Media Players:

1. All media players, including Blu-ray players that are capable of outputting protected content including HDCP and DPCP, shall have a minimum of 16 keys available.

C. Audio/Video GUI Control Systems:

1. Contractor shall furnish a programmable software-based audio/video control system. The system shall be field configurable and programmable by the factory and/or a factory-trained programmer.

2. The control system shall be TCP/IP based allowing direct connection of the system processors to a 10/100BaseT compatible Ethernet network.

3. Refer to project drawings for required central processors, touch panels, keypads and additional information.

D. Microphone Systems:

1. Wireless Microphones:

a. Wireless microphones shall not operate in the 698 to 806 MHz band (channels 52 to 69).

b. Features:

1) Dual antenna reception with true diversity reception.

c. Microphone systems that are common (shared) by multiple spaces or when the receivers are located in a remote area shall include a compatible wireless antenna distribution system by the same manufacturer as the wireless microphone system.

E. Audio Amplifiers:

1. Power Amplifier(s), 25, 70.7 and 100 Volt:

a. Power: The following calculation shall be used to determine the minimum required output of the amplifier(s):

1) Calculate the total power tap value of each transformer with insertion loss using the following equation:

a) Tap wattage x 10^(xdB/10) where x = the rated insertion loss at 1,000Hz.

2) Calculate the total wattage loss based on cable distance, cable gauge and cable resistance.

3) Add together all the speaker taps' total power values that will be on a single channel of the amplifier. Multiply that total by 1.2, which will allow for a 20% future expansion. Multiply that number by 1.25 to ensure the amplifier never exceeds 75% of its total output. Utilize the final number to determine the minimum amplifier power requirements.

F. Assisted Listening Systems (ALS):

1. All spaces with amplified audible communications require an ALS. The Contractor shall refer to the ADA and ADAAG guidelines, as well as IBC Section 1108.2.7 for ALS rules, regulations and guidelines. Refer to the table below for the required number of receivers to be provided for each space (*Source: IBC, Table 1108.2.7.1)*. Alternatively, if the building is managed by a single entity and all systems are fully compatible and interoperable, the total number of seats for all areas can be used in accordance with the table below.

Capacity of Seating in Assemble Areas	Minimum Required Number of Receivers	Minimum Number of Receivers to be Hearing-aid (T-coil) Compatible
50 or less	2	2
51 to 200	2, plus 1 per 25 seats over 50 seats	2
201 to 500	2, plus 1 per 25 seats over 50 seats	1 per 4 receivers
501 to 1,000	20, plus 1 per 33 seats over 500 seats	1 per 4 receivers
1,101 to 2,000	35, plus 1 per 50 seats over 1,000 seats	1 per 4 receivers
Over 2,000	55, plus 1 per 100 seats over 2,000 seats	1 per 4 receivers

2. Receivers required to be hearing-aid compatible shall interface with telecoils in hearing aids through the provision of neckloops and shall be over-the-ear type headphones. Earbuds are not acceptable for this use.

3. Receivers shall include a 1/8” (3.2mm) standard mono output jack.

4. Refer to the Access Board Research "Large Area Assistive Listening Systems: Review and Recommendations" ALS report for additional recommendations.

G. Power Conditioning and Surge Protective Devices:

1. All equipment shall be plugged in through a power conditioning surge arrestor.

2. Provide a minimum of 50 dB noise attenuation.

3. Provide a minimum of 1,500 joules of surge protection.

4. UL 1449 – Standard for Safety for Surge Protective Devices listed to 330 volt clamping voltage.

5. Provide automatic voltage regulation from 97 VAC to 137 VAC at a minimum to maintain a stable 120 VAC where specified.

6. Power sequencers shall be equipped with contact closures **[OR]** bi-directional RS-232 or Ethernet control for remote turn on and off.

7. Refer to the project drawings for additional information.

H. Digital Video Signal Equalizers and Regenerators:

1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install a signal equalizer at the far end (sink) with the following minimum features:

a. HDMI/DVI equalizers shall be HDCP compliant and support actively buffered DDC transmission.

b. Display port equalizers shall be HDCP and DPCP compliant, support actively buffered DDC transmission, and be DP++ compatible.

c. Provide automatic equalization.

d. Pass all embedded audio and metadata.

e. Have an auxiliary power input when adequate power is not available on the cable.

f. Provide output reclocking and jitter reduction for multi-rate SDI signals.

2. For any cable run that that fails to transmit video or audio due to a weak source signal, the Contractor shall provide and install a signal regenerator at the near end (source) with the following minimum features:

a. HDMI/DVI regenerators shall be HDCP compliant and support actively buffered DDC.

b. Display port regenerators shall be HDCP and DPCP compliant, support DDC transmission, and be DP++ compatible.

c. Provide automatic output reclocking and jitter reduction.

d. Pass all embedded audio and metadata.

e. Have an auxiliary power input when adequate power is not available on the cable.

I. Extended Display Identification Data (EDID) Emulators:

1. If any source or Owner-furnished equipment (OFE) is not outputting video properly, the Contractor shall provide and install an EDID Emulator and set it to the highest common EDID table of the displays (sinks) being outputted to, with the following minimum features:

a. EDID capture mode from a display.

b. Have an auxiliary power input when adequate power is not available on the cable.

J. Audio Unbalanced to Balanced Converters, Balanced to Unbalanced Converters, Combiners, Dividers, Isolation Transformers, and Line Drivers Minimum Requirements:

1. Unbalanced to Balanced Active Converter:

a. Provide signal isolation from the audio signals of differing channels.

b. Provide output trim gain and set to optimal output level while preventing over amplification and clipping of the signal.

c. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

d. Provide with appropriate power supply and mounting kit for rack or wall use.

e. Provide appropriate converter for mono to mono, mono to stereo, stereo to stereo, or stereo to mono to match the input of the equipment to which it is being connected.

2. Balanced to Unbalanced Passive Converter:

a. Provide transformer isolation from the input to output.

b. Provide output trim attenuation and set to optimal output level while preventing over-amplification and clipping of the signal.

c. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

d. Provide with appropriate mounting kit for rack or wall use.

e. Provide appropriate converter for mono to mono, mono to stereo, stereo to stereo, or stereo to mono to match the input of the equipment to which it is being connected.

3. Stereo to Mono and Mono to Stereo Passive Combiner/Divider:

a. Passive resistive network.

b. Provide RF filtering.

c. Provide a minimum of 3dB of isolation between channels.

d. Provide no greater than 3dB of Insertion Loss.

e. Minimum frequency response of 20 Hz to 20 kHz (± 3dB).

f. Provide with appropriate mounting kit for rack or wall use.

g. Provide appropriate passive combiner for low impedance or high impedance and balanced or unbalanced signals to maintain the original signal type.

4. Passive Isolation Transformer:

a. Provide Galvanic Isolation.

b. Minimum frequency response of 20 Hz to 20 kHz (± 3dB).

c. Isolate the input shield from the output shield. Input shield is electrically isolated from the transformer chassis and provides a ground return. The output shield is connected to the transformer chassis.

d. Provide with appropriate mounting kit for rack or wall use.

e. Provide appropriate isolation transformer for low impedance or high impedance, stereo or mono signals, and balanced or unbalanced signals to maintain the original signal type.

5. Active Signal Line Driver:

a. Provide balanced or unbalanced inputs with balanced outputs.

b. Provide input trim gain for a minimum of unity gain from -14dBu to +24dBu, set to optimal output level while preventing over-amplification and clipping of the signal.

c. Provide a minimum balanced output of +4dBu nominal for a minimum output gain of +25dBu.

d. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

e. Provide with appropriate power supply and mounting kit for rack or wall use.

f. Provide appropriate line driver for low impedance or high impedance and stereo or mono signals.

K. Refer to project drawings for all other equipment not listed.

2.2 AUDIO CONNECTORS

A. XLR Jack:

1. Panel Mount: Professional grade, crimped insert for vibration control, nickel shell, silver pins, pin quantity as required for application. Switchcraft, Neutrik or approved equal.

B. XLR Plug:

1. Professional grade, 360° strain relief, nickel shell, silver pins. Provide colored boot. Switchcraft, Neutrik, Mogami or approved equal.

C. Loudspeaker Connector:

1. Panel Mount: Twist-lock type, 4-conductor. Neutrik Speakon or approved equal.

2.3 AUDIO CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. Microphone Level Audio Cabling:

1. For patch cables less than or equal to 25 feet:

a. 24 AWG 2-conductor, twisted, stranded (19x36) tinned bare copper.

b. Single Layer Shield:

1) Shield: 100% aluminum foil shield.

c. Nominal Capacitance: 30.0 pF/Ft.

1) Belden 9452
2) West Penn
3) Liberty
4) Gepco

2. For cable runs greater than or equal to 25 feet:

a. 22 AWG 2-conductor, twisted, stranded (16x34) tinned bare copper.

b. Dual Layer Shield:

1) Shield: 85% total tinned copper braid shield.

c. Nominal Capacitance: 18.0 pF/Ft.

d. Acceptable Manufacturers:

1) Belden 8422
2) West Penn
3) Liberty
4) Gepco

C. Line Level Audio Cabling:

1. For patch cables less than or equal to 25 feet:

a. 22 AWG 2-conductor, twisted, stranded (7x30) tinned bare copper.

b. Single Layer Shield:

1) Shield: 100% aluminum foil shield.

c. Nominal Capacitance for non-plenum cable: 24.0pF/Ft.

d. Nominal Capacitance for plenum cable: 35.0 pF/Ft

e. Acceptable Manufacturers:

1) Belden 82761 plenum
2) West Penn
3) Liberty
4) Gepco

2. For cable runs greater than or equal to 25 feet:

a. 18 AWG 2-conductor, twisted, stranded (16x30) tinned bare copper.

b. Single Layer Shield:

1) Shield: 100% aluminum foil shield.

c. Nominal Capacitance for non-plenum cable: 30.0 pF/Ft

d. Nominal Capacitance for plenum cable: 51.0 pF/Ft.

e. Acceptable Manufacturers:

1) Belden 82760 plenum
2) West Penn
3) Liberty
4) Gepco

D. AES/EBU Digital Audio Cabling:

1. For patch cables less than or equal to 25 feet:

a. 24 AWG 2-conductor, twisted, stranded (7x32) tinned bare copper.

b. Single Layer Shield:

1) Outer shield: 100% aluminum foil shield.

c. Nominal Impedance: 110 ohms.

d. Nominal Capacitance: 12.0 pF/Ft.

e. Velocity of Propagation for non-plenum cable: 76%

f. Velocity of Propagation for plenum cable: 78%.

g. Maximum attenuation (per 100 feet):

1) at 2-MHz: 1.3 dB.
2) at 4-MHz: 1.56 dB.
3) at 5-MHz: 1.7 dB.
4) at 6-MHz: 1.81 dB.
5) at 12-MHz: 2.28 dB.
6) at 24-MHz: 3.08 dB.

h. Acceptable Manufacturers:

1) Belden 1801 plenum
2) West Penn
3) Liberty
4) Gepco

2. For cable runs greater than or equal to 25 feet:

a. 22 AWG 2-conductor, twisted, stranded (7x30) tinned bare copper.

b. Dual Layer Shield:

1) Inner shield: 100% aluminum foil shield.
2) Outer shield: 90% tinned copper braid shield.

c. Nominal Impedance: 110 ohms.

d. Nominal Capacitance: 13.0 pF/Ft.

e. Velocity of Propagation: 76%.

f. Maximum attenuation (per 100 feet):

1) at 2-MHz: .93 dB.
2) at 4-MHz: 1.15 dB.
3) at 5-MHz: 1.2 dB.
4) at 6-MHz: 1.3 dB.
5) at 12-MHz: 1.6 dB.
6) at 24-MHz: 1.97 dB.

g. Acceptable Manufacturers:

1) Belden 1696A
2) West Penn
3) Liberty
4) Gepco

E. Constant Voltage Speaker Cabling:

1. Class 2, plenum rated, stranded, twisted, shielded 2-conductor, 16-gauge wire for all 25/70.7/100 volt applications unless noted otherwise.

2. All shielded cables drain wire SHALL be grounded and continuous throughout the entire length of the system. The shield shall be grounded to the building ground system at the amplifier end of the cable only.

3. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

4. As manufactured by Belden 6200FE (plenum), Liberty, Gepco, or approved equal.

F. High Performance Constant Voltage Speaker Cabling:

1. Class 2, plenum rated, stranded, twisted, shielded 2-conductor, 12-gauge wire for all 25/70.7/100 volt high wattage (50-watts per speaker or greater) applications unless noted otherwise.

2. All shielded cables drain wire SHALL be grounded and continuous throughout the entire length of the system. The shield shall be grounded to the building ground system at the amplifier end of the cable only.

3. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

4. As manufactured by Belden 6000FE (plenum), Liberty, Gepco, or approved equal.

2.4 VIDEO CONNECTORS

A. RF Video F-Connector:

1. 75 ohm, broadcast quality, two-piece compression type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and crimp connectors are not acceptable. Corning Gilbert, King, Amphenol or approved equal.

B. BNC Bulkhead:

1. Chassis Mount: 1/2" D jack, 75 ohm, feed-through jack-to-jack type.
2. Recessed: 1/2" D jack, 75 ohm, nickel face, feed-through jack-to-jack type.

C. BNC Connector:

1. 75 ohm, broadcast quality, two-piece compression type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and crimp connectors are not acceptable. Corning Gilbert, King, Amphenol or approved equal.

D. VGA Assembly:

1. 75 ohm, metal shell, connections for coaxial RGBHV cables.

E. RJ-45 Un-shielded Connector:

1. 100 ohm, un-shielded, Category 5e rated, 8-pin, 8-conductor crimp type with strain relief boot. Match manufacturer or manufacturer partner of approved UTP cabling.

F. RJ-45 Un-shielded Jack:

1. 100 ohm, un-shielded, Category 5e rated, 8-pin, 8-conductor punch-down type. Provide with appropriate faceplate; coordinate color with Electrical Contractor. Match manufacturer or manufacturer partner of approved UTP cabling.

G. RJ-45 Shielded Connector:

1. 100 ohm, shielded, Category 6 or 6A rated, 8-pin, 8-conductor shielded crimp type with strain relief boot. Match manufacturer or manufacturer partner of approved ScTP or FTP cabling.

H. RJ-45 Shielded Jack:

1. 100 ohm, shielded, Category 6 or 6A rated, 8-pin, 8-conductor shielded punch-down type. Provide with appropriate faceplate; coordinate color with Electrical Contractor. Match manufacturer or manufacturer partner of approved ScTP or FTP cabling.

2.5 ANALOG VIDEO CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. RF Video Cable:

1. For cable runs less than or equal to 100 feet:

a. RG-6, center conductor: 18 AWG bare copper covered steel; 0.040" OD (nominal); foam FEP insulation (plenum).

b. Four Layer Shield:

1) Inner shield: 100% aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
2) Second shield: 60% 34 AWG bare aluminum braid wire.
3) Third shield: 100% non-bonded aluminum foil tape.
4) Outer shield: 40% 34 AWG bare aluminum braid wire.

c. Nominal Impedance: 75 ohms.

d. Nominal Capacitance for non-plenum cable: 16.2 pF/Ft

e. Nominal Capacitance for plenum cable: 16.3 pF/Ft.

f. Velocity of Propagation: 83%.

g. Maximum attenuation for non-plenum cable (per 100 feet):

1) at 5-MHz: 0.67 dB
2) at 55-MHz: 1.60 dB
3) at 400-MHz: 4.00 dB
4) at 700-MHz: 5.45 dB
5) at 1000-MHz: 6.54 dB

h. Maximum attenuation for plenum cable (per 100 feet):

1) at 1-MHz: 0.3 dB.
2) at 50-MHz: 1.6 dB.
3) at 400-MHz: 4.6 dB.
4) at 700-MHz: 6.6 dB.
5) at 1000-MHz: 8.2 dB.

i. Acceptable Manufacturers:

1) Belden 1189AP plenum
2) CommScope
3) Liberty
4) Gepco
5) Times Fiber

2. For cable runs greater than or equal to 100 feet:

a. For any cable run that exceeds the manufacturer-recommended distances, the Contractor shall provide and install an RF booster amplifier and set the gain and slope to achieve the proper signal level.

b. RG-11, center conductor: 14 AWG bare copper covered steel; 0.064" OD (nominal); foam FEP Teflon insulation (plenum).

c. Four Layer Shield:

1) Inner shield: 100% aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
2) Second shield: 60% 34 AWG bare aluminum braid wire.
3) Third shield: 100% non-bonded aluminum foil tape.
4) Outer shield: 40% 34 AWG bare aluminum braid wire.

d. Nominal Impedance: 75 ohms.

e. Nominal Capacitance: 16.2 pF/Ft.

f. Velocity of Propagation for non-plenum cable: 83%.

g. Velocity of Propagation for plenum cable: 82%.

h. Maximum attenuation for non-plenum cable (per 100 feet):

1) at 5-MHz: 0.38 dB
2) at 55-MHz: 0.97 dB
3) at 400-MHz: 2.47 dB
4) at 700-MHz: 3.37 dB
5) at 1000-MHz: 4.23 dB

i. Maximum attenuation (plenum) (per 100 feet):

1) at 1-MHz: 0.2 dB.
2) at 50-MHz: 1.2 dB.
3) at 400-MHz: 3.5 dB.
4) at 700-MHz: 4.6 dB.
5) at 1000-MHz: 5.6 dB.

j. Acceptable Manufacturers:

1) Belden 1153A plenum
2) CommScope
3) Liberty
4) Gepco
5) Times Fiber

C. Composite Video (YUV) Cable:

1. For patch cables less than or equal to 25 feet:

a. RG-59, center conductor: 23 AWG stranded (7x32) bare copper; 0.023" OD (nominal); polyethylene dielectric.

b. Single Layer Shield:

1) Outer shield: 95% tinned copper braid.

c. Nominal Impedance: 75 ohms.

d. Nominal Capacitance: 21.0 pF/Ft.

e. Velocity of Propagation: 66%.

f. Maximum attenuation (per 100 feet):

1) at 1-MHz: 0.4 dB.
2) at 71.5-MHz: 3.3 dB.
3) at 360-MHz: 8.0 dB.
4) at 750-MHz: 11.9 dB.
5) at 1000-MHz: 13.8 dB.

g. Acceptable Manufacturers:

1) Belden 8279
2) CommScope
3) Liberty
4) Extron

2. For horizontal cable runs less than or equal to 100 feet:

a. RG-59, center conductor: 20 AWG solid bare copper; 0.031" OD (nominal); FEP insulation (plenum).

b. Double Layer Shield:

1) Outer shield: 98% tinned copper braid outside and solid copper braid inside.

c. Nominal Impedance: 75 ohms.

d. Nominal Capacitance for non-plenum cable: 21.0 pF/Ft

e. Nominal Capacitance for plenum cable: 19.0 pF/Ft.

f. Velocity of Propagation for non-plenum cable: 66%

g. Velocity of Propagation (plenum): 71%.

h. Maximum attenuation for non-plenum cable (per 100 feet):

1) at 1-MHz: 0.3 dB.
2) at 71.5-MHz: 2.1 dB.
3) at 360-MHz: 5.1 dB.
4) at 750-MHz: 8.0 dB.
5) at 1000-MHz: 10.2 dB.

i. Maximum attenuation (plenum) (per 100 feet):

1) at 1-MHz: 0.2 dB.
2) at 71.5-MHz: 2.3 dB.

3) at 360-MHz: 6.1 dB.
4) at 750-MHz: 10.0 dB.
5) at 1000-MHz: 12.3 dB.

j. Acceptable Manufacturers:

1) Belden 88281 plenum
2) CommScope
3) Liberty
4) Extron

3. For horizontal cable runs greater than or equal to 100 feet:

a. For any cable run that exceeds the manufacturer-recommended distances, the Contractor shall provide and install a line driver amplifier and set the level and peaking to achieve the proper signal level.

b. RG-6, center conductor: 18 AWG solid bare copper; 0.04" OD (nominal); foam FEP Teflon insulation (plenum).

c. Double Layer Shield:

1) Inner shield: 100% non-bonded aluminum foil tape.
2) Outer shield: 95% tinned copper braid.

d. Nominal Impedance: 75 ohms.

e. Nominal Capacitance: 16.2 pF/Ft.

f. Velocity of Propagation: 82%.

g. Maximum attenuation for non-plenum cable (per 100 feet):

1) at 1-MHz: 0.2 dB.
2) at 71.5-MHz: 1.6 dB.
3) at 360-MHz: 3.4 dB.
4) at 750-MHz: 5.0 dB.
5) at 1000-MHz: 5.9 dB.

h. Maximum attenuation (plenum) (per 100 feet):

1) at 1-MHz: 0.2 dB.
2) at 71.5-MHz: 1.8 dB.
3) at 360-MHz: 4.0 dB.
4) at 750-MHz: 6.2 dB.
5) at 1000-MHz: 7.3 dB.

i. Acceptable Manufacturers:

1) Belden 1695A plenum
2) CommScope
3) Liberty
4) Extron

D. Low Skew Unshielded Twisted Pair (UTP) Cable:

1. The jacket color for Low Skew UTP cable shall be Maroon (Red), Green or Yellow for analog video applications.

2. Maximum Skew ≤ 2.2ns/100m

3. Nominal Impedance = 100 ohms

4. Velocity of Propagation (plenum): 70%.

5. Nominal attenuation (per 100 meters):

a. at 1-MHz: 2.0 dB.
b. at 25-MHz: 10.4 dB.
c. at 100-MHz: 22.0 dB.
d. at 350-MHz: 44.8 dB.

6. Return Loss = 15 dB

7. Intended for analog video applications only; not suitable for use as an IP data cable or digital video cable.

8. Acceptable Manufacturers:

a. Belden Nanoskew 7987P plenum
b. Extron
c. Liberty Cable
d. Mohawk Cable
e. General Cable

2.6 DIGITAL VIDEO CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. High Definition Multi-Media Interface (HDMI) “High Speed” Cable:

1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install am HDCP-compliant signal equalizer at the far end (sink).

2. For cable runs less than or equal to 25 feet:

a. Four (4) 28AWG solid bonded twisted pairs for clock and data, and seven (7) 28AWG solid conductors for control.

b. Two Layer Shield:

1) Inner shield: non-bonded aluminum foil tape.
2) Outer shield: 85% tinned copper braid shield.

c. Nominal attenuation of clock and data pairs (per 100 feet):

1) at 100-MHz: 9.6 dB
2) at 400-MHz: 19.3 dB
3) at 825-MHz: 28.9 dB
4) at 1200-MHz: 36.1 dB

d. Nominal capacitance between shielded pairs: 15.3 pF/ft nominal.

e. Nominal capacitance between control pairs: 16.5 pF/ft nominal.

f. Nominal return loss of shielded pairs: 15 dB, 1-1200 MHZ.

g. Nominal shield DC resistance of individual shield: 24.4 ohms/1000 ft.

h. Nominal shield DC resistance of overall shield: 3.7 ohms/1000 ft.

i. The cable shall be HDMI 1.3a Category 1 certified to 25 feet, and HDMI 1.3a Category 2 certified to 15 feet.

j. Supports a maximum digital data rate of 10.2 Gbit/s.

k. Supports up to eight (8) channels of HD audio.

l. HDCP compliant.

m. Acceptable Manufacturers:

1) Belden BJC Series-F2 as assembled by Blue Jeans Cable
2) Atlona Technologies
3) Extron
4) Approved equal

3. For cable runs greater than 25 feet:

a. Four (4) 24AWG solid bonded twisted pairs for clock and data, and seven (7) 24AWG solid conductors for control.

b. Two Layer Shield:

1) Inner shield: non-bonded aluminum foil tape.
2) Outer shield: 82% tinned copper braid shield.

c. Nominal attenuation of clock and data pairs (per 100 feet):

1) at 100-MHz: 6.0 dB
2) at 400-MHz: 13.5 dB
3) at 825-MHz: 19.8 dB
4) at 1200-MHz: 24.1 dB

d. Nominal capacitance between shielded pairs: 15.3 pF/ft nominal.

e. Nominal capacitance between control pairs: 16.5 pF/ft nominal.

f. Nominal return loss of shielded pairs: 15 dB, 1-1200 MHZ.

g. Nominal shield DC resistance of individual shield: 15.0 ohms/1000 ft.

h. Nominal shield DC resistance of overall shield: 1.75 ohms/1000 ft.

i. The cable shall be HDMI 1.3a Category 1 certified to 45 feet, and HDMI 1.3a Category 2 certified to 25 feet.

j. Supports a maximum digital data rate of 10.2 Gbit/s.

k. Supports up to eight (8) channels of HD audio.

l. HDCP compliant.

m. Acceptable Manufacturers:

1) Belden BJC Series-1 as assembled by Blue Jeans Cable
2) Atlona Technologies
3) Extron
4) Approved equal

C. Digital Video Interface (DVI) Cable:

1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install am HDCP compliant signal equalizer at the far end (sink).

2. Digital Video Interface - Digital, Dual-Link (DVI-DL) Cable:

a. Supports a maximum digital data rate of 7.92 Gbit/s.

b. Acceptable Manufacturers:

1) Blue Jeans Cable DVI-D Single-Link
2) Atlona Technologies
3) Extron
4) Approved equal

3. Digital Video Interface – Digital, Single-Link (DVI-D) Cable:

a. Supports a maximum digital data rate of 3.96 Gbit/s.

b. HDCP compliant.

c. Acceptable Manufacturers:

1) Blue Jeans Cable DVI-D Single-Link
2) Atlona Technologies
3) Extron
4) Approved equal

4. Digital Video Interface – Analog and Digital, Single-Link (DVI-I) Cable:

a. Supports a maximum digital data rate of 3.96 Gbit/s.

b. Supports a maximum analog bandwidth of 400 MHz (-3dB).

c. HDCP compliant.

d. Acceptable Manufacturers:

1) Blue Jeans Cable DVI-D Single-Link
2) Atlona Technologies
3) Extron
4) Approved equal

D. High Definition Serial Digital Interface (HD-SDI) Cabling:

1. For patch cables less than or equal to 25 feet:

a. RG-59, center conductor: 22 AWG stranded (7x29) bare copper, 0.023" OD (nominal), polyethylene dielectric.

b. Single Layer Shield:

1) Outer shield: 98% tinned copper braid.

c. Nominal Impedance: 75 ohms.

d. Nominal Capacitance: 21.0 pF/Ft.

e. Velocity of Propagation: 66%.

f. Maximum attenuation (per 100 feet):

1) at 1-MHz: 0.3 dB.
2) at 71.5-MHz: 2.5 dB.
3) at 360-MHz: 6.0 dB.
4) at 750-MHz: 8.9 dB.
5) at 1000-MHz: 10.5 dB.

g. Acceptable Manufacturers:

1) Belden 8281F
2) CommScope
3) Liberty
4) Extron

2. For horizontal cable runs less than or equal to 100 feet:

a. RG-59, center conductor: 20 AWG solid bare copper, 0.031" OD (nominal), FEP insulation (plenum).

b. Double Layer Shield:

1) Outer shield: 98% tinned copper braid outside and solid copper braid inside.

c. Nominal Impedance: 75 ohms.

d. Nominal Capacitance for non-plenum cable: 21.0 pF/Ft

e. Nominal Capacitance for plenum cable: 19.0 pF/Ft.

f. Velocity of Propagation for non-plenum cable: 66%

g. Velocity of Propagation for plenum: 70%.

h. Maximum attenuation for plenum (per 100 feet):

1) at 1-MHz: 0.2 dB.
2) at 71.5-MHz: 2.3 dB.
3) at 360-MHz: 6.1 dB.

4) at 750-MHz: 10.0 dB.
5) at 1000-MHz: 12.3 dB.

i. Acceptable Manufacturers:

1) Belden 88281 plenum
2) CommScope
3) Liberty
4) Extron

3. For horizontal cable runs greater than or equal to 100 feet:

a. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install a signal equalizer at the far end (sink).

b. RG-6, center conductor: 18 AWG solid bare copper, 0.04" OD (nominal), foam HDPE insulation for non-plenum and foam FEP Teflon insulation for plenum.

c. Double Layer Shield:

1) Inner shield: 100% non-bonded aluminum foil tape.
2) Outer shield: 95% tinned copper braid.

d. Nominal Impedance: 75 ohms.

e. Nominal Capacitance: 16.2 pF/Ft.

f. Velocity of Propagation: 82%.

g. Maximum attenuation for plenum cable (per 100 feet):

1) at 1-MHz: 0.2 dB.
2) at 71.5-MHz: 1.8 dB.
3) at 360-MHz: 4.0 dB.
4) at 750-MHz: 6.2 dB.
5) at 1000-MHz: 7.3 dB.

h. Acceptable Manufacturers:

1) Belden 1695A plenum
2) CommScope
3) Liberty
4) Extron

E. Screened Twisted Pair (ScTP) or Foil Twisted Pair (FTP) Cabling:

1. For patch cables less than or equal to 16.5 feet (10 meters):

a. 4-pair, 26-AWG tinned stranded (7/34) copper conductors, TIA/EIA Category 5E rated.

b. Single Layer Shield:

1) Shield: non-bonded 100% aluminum foil.

c. Nominal Impedance: 100 ohms.

d. Nominal Capacitance (plenum): 46 pF/m.

e. Velocity of Propagation for non-plenum cable: 68%

f. Velocity of Propagation for plenum cable: 72%.

g. Delay Skew: 30ns/100m.

h. Maximum attenuation (per 100 meters):

1) at 1-MHz: 1.8 dB.
2) at 100-MHz: 19.6 dB.
3) at 250-MHz: 32.8 dB.
4) at 350-MHz: 40.0 dB.
5) at 400-MHz: 43.2 dB.

i. Acceptable Manufacturers:

1) Mohawk M5736* plenum

a) Where * = cable color

2) Liberty
3) Belden
4) General Cable
5) Or approved structured cabling manufacture

2. For medium bandwidth and/or medium distance digital video applications:

a. 4-pair, 23-AWG solid copper conductors, TIA/EIA Category 6 rated.

b. Single Layer Shield:

1) Shield: non-bonded 100% aluminum foil.

c. Nominal Impedance: 100 ohms.

d. Nominal Capacitance for plenum cable: 46 pF/m.

e. Velocity of Propagation for non-plenum cable: 68%

f. Velocity of Propagation for plenum cable: 72%.

g. Delay Skew: 30ns/100m.

h. Maximum attenuation (plenum) (per 100 meters):

1) at 1-MHz: 1.9 dB.
2) at 100-MHz: 18.5 dB.
3) at 250-MHz: 30.7 dB.
4) at 500-MHz: 45.7 dB.

i. Acceptable Manufacturers:

1) Mohawk M5817* plenum

a) Where * = cable color

2) Liberty
3) Belden
4) General Cable
5) Or approved structured cabling manufacture

3. For high bandwidth and/or long distance digital video applications:

a. 4-pair, 23-AWG solid copper conductors, TIA/EIA Category 6A rated.

b. Single Layer Shield:

1) Shield: non-bonded 100% aluminum foil.

c. Maximum Skew ≤ 45ns/100m.

d. Nominal Impedance = 100 ohms.

e. Velocity of Propagation: 68%.

f. Nominal attenuation (per 100 meters):

1) at 1-MHz: 1.6 dB.
2) at 25-MHz: 8.7 dB.
3) at 100-MHz: 17.6 dB.
4) at 250-MHz: 31.1 dB.
5) at 500-MHz: 40.7 dB.

g. Intended for digital video applications only; not suitable for use as an analog video cable.

h. Acceptable Manufacturers:

1) Liberty 24-4P-P-L6ASH plenum
2) Belden
3) Mohawk Cable
4) General Cable

2.7 TRANSMISSION CONNECTORS

A. BNC Bulkhead:

1. Chassis Mount: 50 ohm, feed-through jack-to-jack type.
2. Recessed: 50 ohm, nickel face, feed-through jack-to-jack type.

B. BNC Connector:

1. 50 ohm, RF broadcast quality, two-piece compression or crimp type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and connectors are not acceptable. Corning Gilbert, King, Amphenol or approved equal.

C. RJ-45 Shielded Connector:

1. 100 ohm, shielded, Category 6 rated, 8-pin, 8-conductor shielded crimp type with strain relief boot. Match manufacturer or manufacturer partner of approved UTP cabling.

D. RJ-45 Shielded Jack:

1. 100 ohm, shielded, Category 6 rated, 8-pin, 8-conductor shielded punch down type. Provide with appropriate faceplate; coordinate color with Electrical Contractor. Match manufacturer or manufacturer partner of approved UTP cabling.

2.8 TRANSMISSION CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. For patch cables less than or equal to 25 feet:

1. RG-174, center conductor: 26 AWG stranded (7x34) copper-covered steel; 0.019" OD (nominal); polyethylene insulation.

2. Single Layer Shield:

a. Outer shield: 90% tinned copper braid shield.

3. Nominal Impedance: 50 ohms.

4. Nominal Capacitance: 30.8 pF/Ft.

5. Velocity of Propagation: 66%.

6. Maximum attenuation (per 100 feet):

a. at 1-MHz: 1.9 dB.
b. at 50-MHz: 5.8 dB.
c. at 400-MHz: 19.0 dB.
d. at 700-MHz: 27.0 dB.
e. at 1000-MHz: 34.0 dB.

7. Cable shall be installed in conduit within plenum areas.

8. Acceptable Manufacturers:

a. Belden 8216
b. CommScope
c. Liberty
d. Times Fiber

C. For horizontal cables less than or equal to 50 feet:

1. RG-58, center conductor: 20 AWG bare solid copper; 0.037" OD (nominal); polyethylene insulation for non-plenum and FEP Teflon dielectric for plenum.

2. Single Layer Shield:

a. Outer shield: 95% tinned copper braid shield.

3. Nominal Impedance: 50 ohms.

4. Nominal Capacitance for non-plenum cable: 28.5 pF/Ft

5. Nominal Capacitance for plenum cable: 26.4 pF/Ft.

6. Velocity of Propagation for non-plenum cable: 66%

7. Velocity of Propagation for plenum cable: 69.5%.

8. Maximum attenuation for non-plenum cable (per 100 feet):

    a. at 1-MHz: 0.3 dB.
    b. at 50-MHz: 2.5 dB.
    c. at 400-MHz: 8.4 dB.
    d. at 700-MHz: 11.7 dB.
    e. at 1000-MHz: 14.5 dB.

9. Maximum attenuation for plenum cable (per 100 feet):

    a. at 1-MHz: 0.5 dB.
    b. at 50-MHz: 3.0 dB.
    c. at 400-MHz: 9.7 dB.
    d. at 700-MHz: 13.7 dB.
    e. at 1000-MHz: 17.3 dB.

10. Acceptable Manufacturers:

    a. Belden 82240 plenum
    b. CommScope
    c. Liberty
    d. Times Fiber

D. For horizontal cables greater than or equal to 50 feet:

1. RG-8 Center conductor: 10 AWG bare solid copper; 0.108" OD (nominal); foam HDPE insulation for non-plenum and foam FEP dielectric for plenum.

2. Two Layer Shield:

    a. Inner shield: non-bonded aluminum foil tape.
    b. Outer shield: 90% tinned copper braid shield.

3. Nominal Impedance: 50 ohms.

4. Nominal Capacitance for non-plenum cable: 24.8 pF/Ft

5. Nominal Capacitance for plenum cable: 24.2 pF/Ft.

6. Velocity of Propagation for non-plenum cable: 82%

7. Velocity of Propagation for plenum cable: 84%.

8. Maximum attenuation for non-plenum cable (per 100 feet):

    a. at 1-MHz: 0.4 dB.
    b. at 50-MHz: 1.0 dB.

c. at 400-MHz: 2.6 dB.
d. at 700-MHz: 3.6 dB.
e. at 1000-MHz: 4.4 dB.
f. at 4000-MHz: 9.9 dB.

9. Maximum attenuation for plenum cable (per 100 feet):

a. at 1-MHz: 0.1 dB.
b. at 50-MHz: 1.1 dB.
c. at 400-MHz: 3.2 dB.
d. at 700-MHz: 4.5 dB.
e. at 1000-MHz: 5.9 dB.
f. at 4000-MHz: 14.1 dB.

10. Acceptable Manufacturers:

a. Belden 7733A plenum
b. CommScope
c. Liberty
d. Times Fiber

2.9 CONTROL CABLING

A. Provide with plenum-rated jacket where used in a plenum space without conduit.

B. Control:

1. For Bidding Purposes: Two-pair, twisted, shielded, one (1) #18 AWG pair and one (1) #22 AWG pair. Provide with plenum-rated jacket where used in a plenum space without conduit. Provide PVC jacket where installed in conduit or non-plenum areas.

2. Size conductors as required for distance and voltage drop.

3. Coordinate exact requirements with selected manufacturer and system prior to submitting bid.

C. Other Control Circuits:

1. #20 AWG, stranded, shielded cable, number of conductors as required for the applications. Provide with plenum-rated jacket where used in a plenum space without conduit. Provide PVC jacket where installed in conduit or non-plenum areas.

2. Coordinate exact requirements with selected manufacturers prior to submitting bid.

2.10 HORIZONTAL COPPER DATA AND FIBER CABLING AND CONNECTORS

A. Refer to Section 27 15 00 - Horizontal Cabling Requirements, for telecommunications cabling and connector requirements including fiber optics being utilized for A/V systems.

B. Refer to Section 27 17 10 - Testing, for telecommunications cabling testing requirements including fiber optics being utilized for A/V systems.

C. All category-rated copper data cabling and fiber optic cabling shall be installed, terminated, tested and certified by the Division 27 Telecommunications contractor

certified by the selected manufacturers for the copper and fiber optic cabling plant. The Contractor shall submit all cabling and certifications to the Architect/Engineer for approval in the shop drawings.

D. The A/V contractor shall coordinate purchase, installation, testing and certification with the telecommunications contractor for all required category-rated copper data cabling and fiber optic cabling required for A/V system operation prior to bid.

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. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as directed by the manufacturer or required for proper system operation.

C. Mount all touch screen and keypad devices where shown on plans in accordance with Americans with Disabilities Act (ADA) requirements for both side reach and front reach.

D. Cabling Requirements:

1. Non-plenum rated cabling may be used instead of plenum when installed with-in conduit in plenum rated areas.

2. All cabling shall be routed according to function. Cabling shall be grouped and bundled by groups, such as: microphone and line level audio, control, video and speaker. In no case shall cabling from different functional groups be intermixed. No cabling shall be routed parallel to 120 VAC or higher power circuits unless separated by a minimum of 6" and the 120 VAC or higher power is installed in conduit.

3. When cabling is installed in conduit, a separate conduit shall be provided for each cabling functional type.

4. Cable bundles shall be loosely bundled to allow the visual following of individual cables within the bundle and to permit the easy removal and addition of cables as necessary.

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 zip ties is strictly prohibited in any situation.

6. Cabling shall not be spliced under any circumstances.

7. Each cable shall be appropriately identified (as defined on the record documents) at each end's termination point using pressure sensitive label strips.

8. Audio Cabling:

   a. All amplified audio cabling shall not be located in the same enclosed pathway as any other type of cabling as required by the NEC. Refer to the NEC for definitions and additional requirements.

   b. The polarity of all cabling shall remain consistent throughout the project, on all equipment. Red conductors shall be used for the positive "+" side, and black used for the negative "-" side.

   c. Cable shield length shall be equal to the cable's conductor length.

   d. All shielded cables drain wire SHALL be grounded and continuous throughout the entire length of the system, including splices where speakers are installed.

   e. Balanced audio connections shall be used whenever the mating equipment allows.

   f. Do not run unbalanced cables longer than 3m. For interconnecting of unbalanced equipment in lengths longer than 3m, the Contractor shall provide a line driver located at the source.

9. Video Cabling:

   a. All video cabling, unless otherwise noted, shall be provided with BNC connectors of the two-piece compression type. Twist-on BNC connectors are not permitted.

   b. Provide BNC 75 ohm terminators where required for all open BNC connectors.

   c. All coaxial video cables used for S-video, component/RGB and RGBHV shall be the same length to minimize skew.

10. Twisted Pair Cabling for All Applications:

    a. The Contractor shall ensure that the twists in each cable pair are preserved to within 0.5 inch of the termination. The cable jacket shall be removed only to the extent required to make the termination.

    b. The Contractor shall ensure that the cable shields are continuous throughout, terminated, and grounded according to the manufacturer's recommendations.

E. Grounding Requirements:

1. Provide a minimum of #6 AWG conductor from the nearest electrical service ground bus or nearest telecommunications room ground bus bar to the A/V equipment racks and cabinets regardless of location. Size cable as required by the NEC.

2. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the equipment end.

3. Audio cable shields for line-level signals shall be connected to the metal equipment chassis at both ends of the cable.

4. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.

5. The Contractor shall not connect cable shields together from differing cables.

6. XLR cable shields shall be connected to chassis ground.

7. Signal-grounded balanced shields are not acceptable and shall not be installed. All balanced shields shall be chassis grounded.

F. Rack and Cabinet Requirements:

1. Ground equipment racks/cabinets as noted within this specification section and Section 27 05 26 - Communications Grounding.

2. Provide one (1) RU of space between adjacent pieces of equipment with top and/or bottom vents, above the topmost piece of equipment, and below the bottommost piece of equipment. Provide a vented cover panel covering each rack space.

3. Terminate all speaker cabling on individual barrier strips for positive "+", negative "-", and shield. The shield barrier strip shall be grounded.

4. Provide a power conditioning surge arrestor in the rack for distribution of AC power from the wall receptacles indicated on the plans. The quantity of plugs shall be adequate so that no equipment in the rack shall require plugging into an AC source outside the rack.

5. Power sequencing shall be provided in the racks where shown on the drawings. All amplifiers located in the racks shall be sequenced “last on – first off”. Power sequencers shall provide power conditioning and surge protection.

G. Video System Installation Requirements:

1. The Contractor shall perform calculations for the optimal distance from the screen to the projector lens based on actual field conditions and submit to the Architect/Engineer for review and approval.

2. If the projector and screen are in a fixed position, the Contractor shall provide the appropriate lens for the throw distance.

H. Audio System Installation Requirements:

1. The Contractor shall perform calculations for the optimal speaker tap settings to reach the desired SPL level and coverage without overloading the amplifier(s).

a. At a minimum, the following calculations shall be used:

1) Add together all speaker taps that will be on a single channel of the amplifier. Multiply that total by 1.2, which will allow for a 20% future expansion. Multiply that number by 1.25 to ensure the

amplifier never exceeds 75% of its total output. Utilize the final number to determine the minimum amplifier power requirements.

2. Connections of balanced to unbalanced equipment shall only be done through an active converter at the unbalanced side.

3. Connections of unbalanced to balanced equipment shall only be done through an active converter at the unbalanced side.

4. Connections from stereo balanced or unbalanced equipment to mono equipment of the same signal type shall only be done through a passive combiner.

5. Connections from mono balanced or unbalanced equipment to stereo equipment of the same signal type shall only be done through a passive divider.

6. The Contractor shall provide an isolation transformer for any balanced or unbalanced audio line that exhibits a hum, noise from EMI or RFI, power line noise, or ground loops.

7. The Contractor shall provide an active audio line driver for all balanced and unbalanced signals that exceed the distance limitations of the cabling.

I. Control System Installation Requirements:

1. The Contractor shall perform calculations for the required wire AWG size based on distance for system power for touch panels, keypads and other devices being powered. A minimum of a 15% overhead is required.

3.3 VIDEO SYSTEM PERFORMANCE REQUIREMENTS

A. Digital Media:

1. Each digital media cable shall certify to a minimum of 4.46 Gpbs for all applications up to 1920x1080P/30.

2. Each digital media cable shall certify to a minimum of 6.68 Gpbs for applications at 1920x1080P/60 or above and for all 3D applications.

3.4 VIDEO SYSTEM TESTING AND CALIBRATION

A. All video equipment shall receive proper testing and configuration.

B. Color Space Optimization:

1. The Contractor shall set the color space of each source and display device to a uniform color space to optimize the switching speed and compatibility of a digital video system. Each device shall be set to an RGB or YCbCr color space depending on the systems primary function and compatibility of the devices.

2. If the primary function of the space is video and other digital media, the color space of each device shall be set to a YCbCr color space. If the primary function of the space is computer-based graphics and presentations, the color space of each device shall be set to an RGB color space.

3. Chroma subsampling shall be set to a consistent 4:4:4 or 4:2:2 across all devices. Set to 4:4:4 when all equipment is capable.

4. If all devices are not capable of displaying a certain color space, all devices shall be set to a common shared color space.

C. Extended Display Identification Data (EDID) Management:

1. The Contractor shall set the EDID management tables in capable equipment so all sources output the highest common EDID table of the displays (sinks).

2. For systems with capable matrix switches, the matrix shall dynamically adjust its EDID tables so any source will output the highest common EDID table of the displays (sinks) being outputted to.

3. If any source or Owner-furnished equipment (OFE) is not outputting properly, the Contractor shall provide and install an EDID Emulator and set it to the highest common EDID table of the displays (sinks) being outputted to.

D. Projector, monitors and receivers shall be tested and adjusted for proper signal sync, convergence, brightness, contrast, and color level. The Contractor shall adjust all other parameters necessary to achieve a proper video image.

E. All video source selections shall be tested and verified.

F. All projectors and displays shall have a minimum burn-in time of 96 hours prior to any adjustments are made and the completion of the project

G. All projectors and displays shall have their hue/tint and color/saturation calibrated with a video signal test generator and blue lens filter after a minimum warmup time of 20 minutes. Provide all calibrated settings results for each projector and display in the final documentation.

H. All projectors and displays shall have their brightness, contrast and sharpness calibrated with a video signal test generator after a minimum warmup time of 20 minutes. Provide all calibrated settings results for each projector and display in the final documentation.

I. All dynamic contrast functions shall be turned off.

J. The Contractor shall utilize a portable oscilloscope to set video output gain and peaking levels on all line drivers and receivers for analog signals.

1. The Contractor shall submit screen shots of the fixed signal.

2. Calibration by eye is not acceptable.

K. Full video calibration for all projectors and displays shall be provided with the following minimum requirements:

1. The Contractor shall utilize non-contact professional video calibration tools such as Sencore OTC1000-CM ColorPro Optical Tri-stimulus Colorimeter or Klein K-10 Tri-stimulus CIE Colorimeter, Sencore or Extron Video Generator and the latest version of ColorPro by CalMan software or approved equal.

2. The projector or display shall have a minimum burn-in time of 96 hours prior to calibration.

3. The projector or display shall have a minimum warmup time of 20 minutes before calibration begins. All efforts shall be taken to allow the display to warm up for a minimum of 60 minutes to allow the luminance to fully stabilize.

4. The space shall be as dark as possible. The colorimeter's ambient light sensor filter shall be recalibrated every 30 minutes when outside ambient light is present to account for the changes in daylight levels.

5. All inputs utilized on the projector or display shall be calibrated using the appropriate video signal, aspect ratio and resolution. Submit results for each input as a separate report.

6. The projector or display shall be calibrated to the Rec. 709 HDTV color standard. White balance shall be calibrated as close as possible to the D65 point for both high IRE and low IRE levels.

7. The projector or display shall have its 3D Color Management calibrated.

8. The projector or display shall have its brightness and contrast adjusted both before and after the gamma is calibrated.

9. Gamma shall be calibrated to an average of 2.2. Gamma shall be verified after the calibration is completed and readjusted as necessary.

10. The projector or display shall have its hue/tint and color/saturation calibrated with a blue lens filter.

11. Record the full on/full off contrast ratio both before and after calibration. Provide these results in the final documentation.

12. The Contractor shall submit the final calibration results to the Architect/Engineer for approval and include the approved results in final documentation submitted to the Owner.

13. Calibration by eye is not acceptable.

14. Any setting that cannot be calibrated because the projector or display lacks the functions shall be noted in the final documentation.

15. For video wall applications, or where multiple projectors or displays that will share content are being used within a single space, all displays after calibration shall be adjusted to match the lowest performing projector or display so all projectors or displays are uniform. If a projector or display differs greatly from the other displays, that projector or display shall be replaced at no cost to the Owner and recalibrated.

3.5 AUDIO SYSTEM TESTING AND CALIBRATION:

A. This Contractor shall adjust any surface-mounted or flown loudspeaker orientation to achieve the necessary coverage pattern.

B. All speakers shall be connected in-phase.

C. The Contractor shall make incremental adjustments on the equipment output and input tolerances to achieve matching signal levels.

D. The Contractor shall utilize a Real Time Audio (RTA) spectrum analyzer with AES2 Broadband pink noise at a minimum of 1/3 octave, capable of providing detailed plots and reports.

E. The Contractor shall provide graphic plots of the reference ambient noise for each space at the time of the calibration and submit with the calibration results.

F. The Contractor shall use a listener sitting height of four (4) feet ± 1" for rooms where the primary function will be sitting. The Contractor shall use a listener standing height of five feet three inches (5.25') ± 1" for rooms where the primary function will be standing.

G. Calibration by ear is not acceptable.

3.6 AUDIO SYSTEM PERFORMANCE REQUIREMENTS

A. The Contractor shall test and provide documents verifying all the following performance criteria. The Architect/Engineer shall be informed when the testing will take place and have the option to witness the testing and ask for additional testing for any reason.

B. The Contractor shall develop an Audio Coverage Uniformity Measurement Location (ACUML) plan for each required space based on the project floor plans, and submit to the Architect/Engineer for review and approval prior to testing. The plan shall represent the majority of the listening areas and a "sweet" spot directly under an overhead speaker in the center of the listening area or directly in line of a point source speaker.

C. The tests shall be performed at the multiple locations defined on the ACUML plan representing the majority of the listening area(s). The Contractor shall indicate on the floor plan drawings where each test was performed, with the corresponding graphic plot, and submit with the final documentation for review and approval by the Architect/Engineer.

D. The test shall be taken with AES2 Broadband pink noise at a minimum of 25 dB above the reference ambient noise level, taking caution to not overdrive and clip any component of the system beyond 0.5% Total Harmonic Distortion (THD), with a maximum system THD of 1.0%.

E. The audio system(s) shall meet the following minimum requirements:

1. Achieve a total average SPL of 95 dB.

2. The system's total SPL frequency response shall be within ± 4 dB from 250 Hz to 8000 Hz. All efforts shall be made to equalize the system's frequency response as flat as possible throughout the system's entire 20Hz-20kHz spectrum.

3. All vocal microphones shall have high and low pass filters set to minimize rumble, pop and hiss. The high pass filter cutoff frequency shall be set between 80 and 100 Hz, with a 12 dB per octave slope. The low pass filter cutoff frequency shall be set at 12,000 Hz, with a 12 dB per octave slope. Adjust frequency and slope as required to maximize performance for both male and female voices.

4. The subwoofer/speaker low/high crossover points shall be a Butterworth (BW) filter set at 80 Hz with a 24 dB per octave slope. This crossover point shall be adjusted as needed to achieve a smooth frequency response.

5. Achieve a minimum RaSTI value of 0.63.

3.7 ASSISTED LISTENING SYSTEM (ALS) PERFORMANCE REQUIREMENTS

A. The Contractor shall verify that the ALS system(s) meets the following minimum performance requirements at the earphone or headset:

1. Reach a minimum total SPL of 110dB and no greater than 118dB, with a minimum of a 50dB dynamic range volume control.

2. Achieve a minimum Speech Transmission Index (STI) value of 0.84.

3. Achieve a minimum signal-to-noise (S/N) ratio of 18dB. It is recommended to achieve a minimum signal-to-noise (S/N) ratio of 25dB to accommodate children.

4. Ensure the peak clipping levels do not exceed 18dB down from the peak input signal level.

B. FM-based systems shall operate within the FCC-reserved assisted listening frequencies of 72 to 76 MHz or the 216 to 217 MHz (preferred) range and comply with the FCC transmitter power requirements.

3.8 DSP-BASED AUDIO PROCESSOR PROGRAMMING

A. Full system programming shall be provided for the system. Programming shall be performed by a factory trained and certified programmer or an employee of the equipment manufacturer.

B. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define the exact DSP requirements of the audio system prior to installation of the audio headend system and components.

C. The IP-based audio (Cobranet, IEEE AVB, Dante, Ethersound, etc.) and components shall be on a dedicated Virtual LAN (VLAN) for the A/V systems. These components shall be on a dedicated subnetwork of the VLAN. The Contractor shall coordinate these requirements with the Owner prior to installation.

D. A 16-band parametric EQ shall be provided after each crossover point. These shall be utilized to set the room to flat as defined in the Audio System Calibration section within this specification. These equalizers should not be made available to the user to adjust.

E. Levelers, compressor/limiters, duckers, gates and delays should be programmed in and made available to the user for adjustment via the system software installed on the computer as described within this specification section.

F. 1/3 octave 31-band EQs, 16 band parametric EQs, feedback eliminators and suppressors, high-pass filters, low-pass filters, levelers, compressor/limiters, duckers, gating and other functions shall be provided for inputs and outputs as required. These settings should be made available to the user for adjustment via the system software installed on the workstation computer as described within this specification.

G. A broadband pink noise generator shall be provided with a selectable on/off control button on the touch panel. The noise shall be run through all processing EQs and effects.

H. Provide meters for each monitorable function.

I. Provide with user control software to be installed on Owner-provided and installed computer.

J. Provide user level access to the above stated functions at a minimum, unless noted otherwise.

K. The Contractor shall utilize the latest version of the programming software.

L. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

M.

3.9 DSP-BASED AUDIO PROCESSOR CONTROL SOFTWARE PROGRAMMING

A. Full system software programming shall be provided for the system. Programming shall be performed by a factory-trained and certified programmer or an employee of the equipment manufacturer.

B. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact page layout requirements prior to the final configuration of the audio system. An Owner sign-off of the final layouts shall be required.

C. The Contractor shall use the latest version of the software.

D. At a minimum, there shall be password-protected pages for zone combining, input/output volume control with meters, speaker output volume control with meters, signal routing, signal processing (EQ's, feedback suppression, etc.), and supervision/maintenance for all spaces and combined zones.

3.10 MULTIMEDIA CONTROL SYSTEM INTEGRATION AND PROGRAMMING

A. Programming and Integration for Control Systems:

1. Full system programming shall be provided for the system. Programming shall be performed by a factory trained and certified programmer or an employee of the equipment manufacturer.

2. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact integration requirements of the control system prior to the installation of the control system and components. An Owner sign-off of the final configuration shall be required.

3. This section only defines the minimum requirements. The programmer shall provide complete programming for a fully functional system.

4. The Contractor shall utilize the latest version of the programming software.

5. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

6. The IP-based control system and controlled components shall be on a dedicated Virtual LAN (VLAN) for the A/V systems. These components shall be on a dedicated subnetwork of the VLAN. The Contractor shall coordinate these requirements with the Owner prior to installation.

7. Integration and programming of the following pieces of equipment shall be provided, with the following minimum features and functions:

   a. All equipment shall include on/off control, with the exception of equipment that must remain active for system functionality.

   b. Integration of HDCP (High-bandwidth Digital Content Protection) and DPCP (Display Port Content Protection) protected content and sources:

      1) No protected sources or content shall be allowed to be selected to route through non-protected devices and displays. A warning shall be displayed stating this information to the user.

   c. Power Supply Integration:

      1) The Contractor shall provide power connections and programming with the following minimum functions:

         a) On/off status of all outputs
         b) Voltage level of all outputs
         c) Ambient temperature and fault status

   d. Matrix Switcher Integration:

      1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

         a) On/off control of the matrix switcher.

         b) Allow for independent video routing of individual video inputs to any audio number of audio outputs.

         c) Allow for audio follow video switcher mode.

         d) Provide source detection of video inputs.

         e) HDCP (High-bandwidth Digital Content Protection) and DPCP (Display Port Content Protection) Protection:

            (1) HDCP-compliant switchers shall allow HDCP source devices to only route to HDCP compliant devices.

            (2) Room Combining/Uncombining features shall allow for complete audio and/or video devices to be connected to the system using simplified interface.

   e. DSP Audio Processor Integration:

      1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) On/off control of all microphones.
b) Volume and mute control of all microphones and input sources.
c) Volume and mute control of all outputs.
d) Independent volume and mute control of all assisted listening outputs.
e) On/off and reset control of feedback eliminators and suppressors.
f) Advanced routing of audio signals.
g) Audio conferencing dialer keypad with speed dials.
h) Audio conferencing CallerID display on touchpanel and/or workstation.
i) Acoustic Echo Cancelation (AEC) control.

f. Projector Integration:

1) The projectors shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. Provide with the following minimum functions:

a) On/off control.
b) Lamp status feedback.
c) Filter status feedback.
d) Source switching control.
e) Audio volume control with mute.
f) Video mute.
g) Auto image.

g. Display Integration:

1) The displays shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. Provide with the following minimum functions:

a) On/off control.
b) Display status feedback.
c) Source switching control.
d) Audio volume control with mute.
e) Video mute.
f) Tuner channel control with direct channel access.
g) Station presets with station icons.

h. Motorized Projection Screen Integration:

1) Screens shall be integrated into the A/V control system via contact closures.

a) Up/down and stop control shall be provided.

i. Pan/Tilt/Zoom (PTZ) Camera Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Provide full pan, tilt and zoom control.

b) Provide presets for fixed camera positions.

(1) The Contractor shall coordinate with the Owner for desired preset positions.

j. DVD/Blu-ray and/or VCR Player Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Typical DVD/Blu-ray and/or VCR functions shall be provided.

b) Real time metadata (if available).

c) Player status feedback.

d) Provide standard Blu-ray menu navigation Red, Green, Blue and Yellow buttons, in that order, for touch panel-based systems.

k. CD Player/Changer Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Typical CD player functions shall be provided.
b) Direct disk load 0-9 numbers.
c) Direct track 0-9 selections.
d) Real time metadata (if available).

l. Power Sequencer Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Power on/off control.

b) On/off status via +12VDC output from the sequencer to the I/O input of the control system processor.

m. Digital Audio Mixing Board Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) On/off control of device.

b) Master volume control.

c) Scene or preset recall.

d) This defines only the basic integration requirements. Coordinate with Owner on additional required functions.

n. Divisible Room Integration and Programming:

1) The following represents the minimum integration and programming requirements for divisible rooms.

a) The touch panel shall show a grid or map of the rooms and spaces that are combinable.

b) The user shall be able to highlight a group of rooms or spaces in any combination and hit combine.

(1) Once combined, all functions shall operate as a single space including, but not limited to, master audio volume control and lighting.

(2) All input sources shall be selectable to be output to any combination of displays.

c) Once rooms are combined all speaker volume levels shall normalize and all volume controls shall adjust the system as a whole.

d) Once rooms are combined all lighting levels shall normalize and all lighting controls shall adjust the system as a whole.

B. Programming and Configuration for Touch Panels:

1. This section only defines the minimum requirements. The programmer shall provide complete touch panel layouts and programming for a fully functional system.

2. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact touch panel layout requirements prior to the purchase and installation of the touch panels. An Owner sign-off of the final layouts shall be required.

a. Some tabs, pages, buttons and functions may be required to have a password at the Owner's discretion. This shall be coordinated during the meetings.

3. Contractor logos are not allowed on the touch panels. The Contractor shall coordinate with the Owner on desired logos to be displayed.

4. All programming for interface and control of all devices shown on the drawings shall be provided. Programming shall be provided for the following minimum functionality:

a. The main screen shall include graphical buttons for the primary room functions.

1) Upon selection of the graphical button, all the required functions shall be displayed on the screen. All required equipment shall turn on.

b. Master System On/Off Control:

1) When the master system off button is selected, all capable components within the system shall be turned off or placed on standby, with the exception of equipment that is required to remain on for the system to function like the control system processor.

c. The main screen shall include graphical buttons for the selection of individual source selections.

1) Upon selection of the graphical button for a source selection, all functional controls for the pieces of equipment, as well as all status indicators, shall be provided in graphical format on the screen.

2) Rooms with multiple independent outputs and displays shall have a source routing matrix to allow any input to be routed to any output.

d. The main screen shall include a button for advanced equipment status and monitoring.

1) Upon selection of the graphical button, the page shall display the on/off status of all monitored equipment, projector lamp hours, projector filter status, and all other features listed within this section that require monitoring.

e. The main screen shall include a button for microphone volume control and muting.

1) Upon selection of the graphical button, it shall display the individual volume level of each wired and wireless microphone, with a mute for each.

2) Rooms with multiple independent audio outputs and zones shall have a source routing matrix to allow any input to be routed to any output or zone.

f. At all times, on all screens, a button shall be provided to return to the main screen, with the exception of modal pop-ups.

g. A master volume control and mute shall be provided at all times on all screens, with the exception of modal pop-ups.

h. A master video mute shall be provided at all times on all screens, with the exception of modal pop-ups and audio-only functions.

i. A modal countdown timer shall be displayed showing the warmup and cooldown time of the projector. All functions shall be locked out while the projector is in cooldown mode.

j. All unused hard buttons shall not be labeled. A blank touch panel bezel shall be provided if no hard buttons are used.

C. Touch Panel Layout Principles, Considerations and Guidelines:

1. Icons and Buttons:

a. Icons shall not be used solely as a button but can be embedded in a button.

b. Icons shall appear to be flat and unpressable.

c. Status bars or text windows for time, date, room number, and similar information shall appear to be slightly depressed into the screen and appear to be unpressable.

d. Buttons shall appear to be pressable by appearing to come off the screen with beveled edges, lighting gradients, and shadows. When pressed, the button shall appear to be depressed into the screen.

1) Buttons that are momentary shall change color when pressed, appear to depress, then pop back up and revert to the original button color and state.

2) Buttons that are not momentary shall change color when pressed, appear to depress, remain depressed, then pop back up, and revert to the original button color and state when pressed again.

e. Buttons and icons shall appear to be lit from the top left corner of the screen.

f. Buttons shall be grouped together according to general function.

g. Button size shall be based on the ratio of Phi (1:1.618) and be sized appropriately based on the screen area and dpi (pixel pitch).

h. Maintain a minimum of 5 to 10 pixels between buttons on small to medium touch panels, and a minimum of 10 to 15 pixels between buttons on medium to large touch panels.

i. Telephone dialer keypads shall be based on the ITU-T E.161/ANSI TI-703 standard telephone layout and include the a-z letters below each appropriate number.

j. TV and radio tuner keypads shall be based on the ITU-T E.161/ANSI TI-703 standard telephone layout, with the exception of the asterisk (*) being replaced by a dot (.) and the pound (#) being replaced with Enter.

k. IP-address keypads shall be based on the standard computer keyboard 10-key numeric keypad typically found on the right side of the keyboard.

l. Buttons such as Power, Play, Stop, Record, Rewind, Previous, Forward, Eject, Return, Next, Up, Down, Left, Right, Plus, Minus, etc. shall use standard industry symbols. Record shall always be a solid red circle.

2. Text and Fonts:

a. The Contractor shall used a standard sans-serif bold **Arial** or **Calibri** font style unless the Owner dictates otherwise.

b. Words shall have the first letter capitalized and the rest of the word lower case. No words shall be all capitals or all lower case. Follow standard grammatically correct sentence structure where the first word is capitalized and the rest of the sentence is lower case, followed by the appropriate punctuation mark with accurate syntax and correct verbs.

c. All font size in a single group or cluster shall maintain the same font size. Headers to a group or cluster shall have a slightly enlarged font size. and footers shall have a slightly smaller font size in comparison to the group font size to maintain a visual hierarchy.

3. Color Considerations:

a. Colors shall be selected so that, when converted to monochrome, all text, buttons, icons, groups, clusters, borders, etc. are clearly visible to accommodate all color blind or color-impaired individuals and ADA requirements.

b. Background colors shall be cool low saturation colors such as grey, blue, or green and their analogous colors, and be a gradient from top down or top left to bottom right.

c. Base colors shall be analogous to the background color but be of a higher saturation to stand out more clearly.

d. Button colors shall be analogous to the background color, stand out clearly from the base colors, and be of a higher saturation cool color, gray, or a low saturation black.

e. Icon, symbols, and text color shall be a neutral white or black, or a low saturation grey, and shall clearly stand out from the background or button it is placed on.

f. Buttons for modal acknowledgement, exit or return, or other modal action shall be a warm color such as red or yellow and their analogous colors.

g. Buttons, icons, symbols or text for emergency or urgent notifications shall be bright red.

4. Pages and Background:

a. Groups and clusters shall have clearly defined borders, with spacing between adjacent groups.

b. Modal pop-up windows or pages shall be required when a command requires user input before it is executed or when a button has multiple

nested elements to control, such as microphone volumes, zone control, lighting and environment control, advanced system controls, etc.

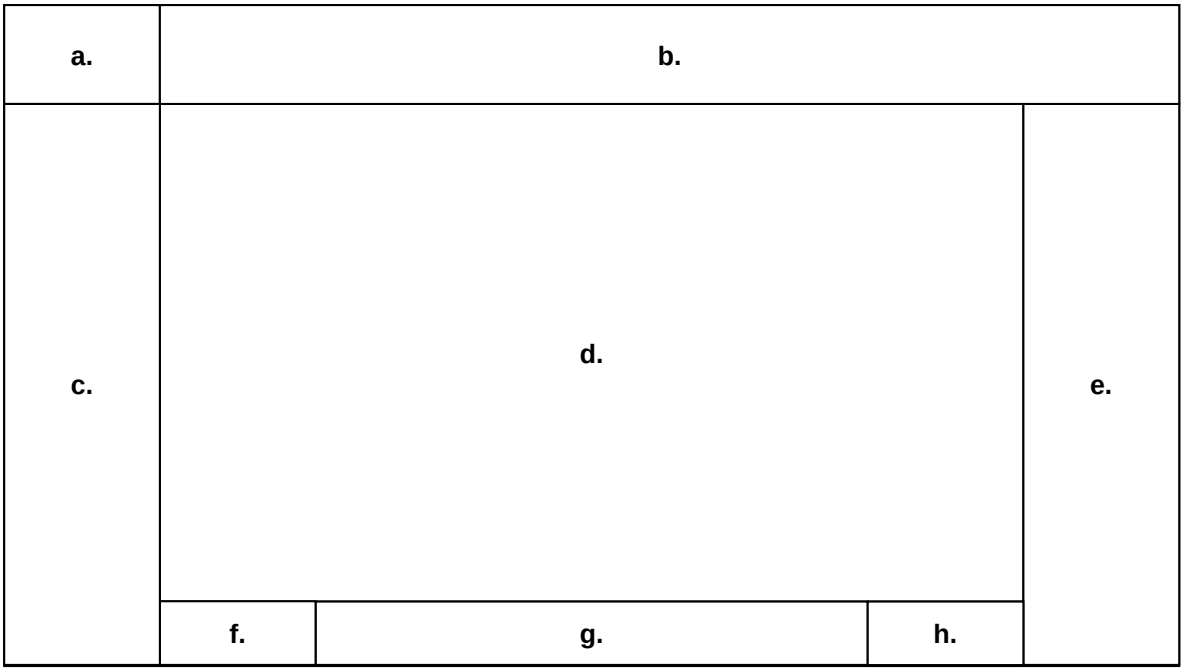
1) The modal pop-up pages shall dim and grey out the background and buttons, overlay the main page, and have a clear back or exit button to bring the user back into the active page the user was on before the modal pop-up.

2) A model pop-up timer page shall appear when a projector is being turned on or off for the appropriate warmup or cooldown time. No additional commands shall be allowed during this time.

3) Model pop-ups shall not replace or completely overlay the background.

c. Images or pictures shall never be used as backgrounds to any page other than a master start page, if appropriate.

5. Medium to Large Format Touch Panel Layout Guideline Template:



a. Client Logo – Static Window

b. A/V Source Selection – Static Window

c. Display Power, Screen Controls, Light Controls, Shade Controls, and other Environmental Controls – Static Window

d. Controls for Selected Source and Status or Home Page – Dynamic Window

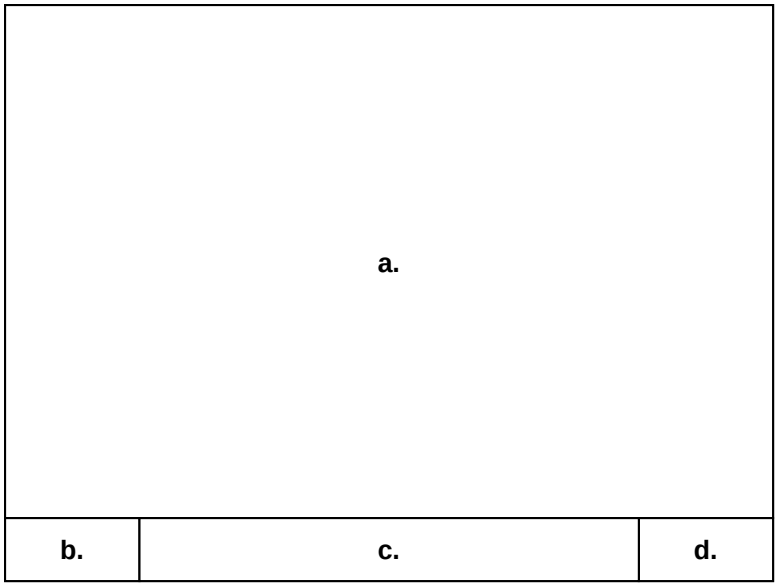
e. Master Volume and Mute, Video Mute, and Microphone Volume – Static Window

f. Home Button – Static Window

g. Date, Time, and Room Number – Static Window

h. Master System Off – Static Window

6. Small Format Touch Panel Layout Guideline Template:



a. A/V Source Selection and Source Control and Status After Selection – Dynamic Window

b. Home Button – Static Window

c. Date, Time, and Room Number – Static Window

d. Master System Off – Static Window

D. The system shall be based on Extron's latest version of GlobalViewer GlobalViewer Enterprise edition.

1. The Contractor shall include programming and integration of Extron's GlobalViewer Enterprise interface for two (2) computers.

E. A series of meetings shall be scheduled by the Contractor with the Owner, Architect/Engineer, and control system manufacturer to determine all required functions, reports, and statistics to be utilized. An Owner sign-off of the final layouts and configuration shall be required. At a minimum, provide the following:

1. Hardware polling for system diagnostics.
2. Processor “on line” status.
3. Rooms system on/off status.
4. Display presence.
5. Display on/off status.
6. On/off switching capabilities with log of devices used.
7. Which devices are in use.
8. Event/error codes.
9. Lamp status.
10. Filter status.
11. Equipment fault or out of tolerance status
12. Room scheduling with on/off control of system.
13. Scheduling of digital signage displays including video walls on/off control and status (if digital signage system in not capable of controlling the displays).
14. Status of lights in room (if applicable).
15. Motion detection in room (if applicable).
16. Log of audio and video conference numbers and IP addresses.
17. .
18. Reporting features would be included for the following:
    a. Lamp life.
    b. Room system usage.
    c. Device usage.

F. The Contractor shall include Extron's GlobalViewer for Pocket PC for Windows-based PDAs and smart phones.

3.11 SYSTEM COMMISSIONING

A. The Contractor shall notify the Architect/Engineer and Owner prior to conducting final system commissioning.

B. Contractors’ tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 09 00 - General Commissioning for additional information.

C. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 09 00 - General Commissioning for system verification tests and commissioning requirements.

D. Contractor shall demonstrate system performance of all equipment and adjust settings as directed by the Architect/Engineer and/or Owner.

1. All system settings, software options and other parameters shall be simulated and tested by the Contractor

3.12 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. 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.

3.13 FIELD SERVICES

A. The installer shall conduct a planning meeting with the Owner. The purpose of this meeting shall be to determine all equipment settings that are considered preferences (where proper system operation does not depend on the setting).

B. The installer shall include labor for all planning and all programming activities required to implement the Owner's preferences for equipment settings.

C. It shall be the responsibility of the Contractor/installer to provide a complete, functional system as described by the design documents. These responsibilities include:

1. Complete hardware setup, installation and wiring and software configuration.

2. Complete programming of software in accordance with the Owner's desires determined by the planning meeting.

3. Complete system diagnostic verification.

4. Complete system commissioning.

3.14 SYSTEM ACCEPTANCE

A. The Contractor shall submit for review a formal acceptance and system checkout procedure. The system checkout procedures shall include all system components and software. The Contractor shall perform the tests and settings and document all results.

3.15 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided for the system. The documentation shall describe:

1. All operational parameters of the system.
2. Complete documentation of programming and features.
3. Complete operating instructions for all hardware and software.

B. The following sections shall be provided in the system documentation:

1. User Manual: A step-by-step guide and instructions detailing all system user functions.

2. Technical Manual: A comprehensive document providing all system operations, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.

3. Maintenance Manual: A comprehensive document on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning, filter changing and UPS maintenance.

C. Intellectual Property Ownership:

1. All intellectual property shall remain in escrow for an unlimited period of time. Should the integrator and/or programmer liquidate or fail to maintain applicable services, all latest versions of the supporting documentation, programming, uncompiled source code, graphic files, DSP code and diagrams, written and electronic files, including all documentation and software necessary to edit and adapt the system(s), shall be provided to the Owner at no charge.

a. A written release shall be given by the integrator and/or programmer and all other required parties for all programming done by the personnel or subcontractors for the project. This release will acknowledge the client's ownership and right to modify the intellectual property directly, or to have the intellectual property modified by any party of the Owner's choosing.

3.16 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. User Manual: A course detailing the system functions and operations that a daily user will encounter.

2. Technical User: Provide configuration training on all aspects of the system(s), including equipment and software.

3. Maintenance User: Provide training on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning and filter changing.

C. Minimum on-site training times shall be:

1. User Manual: Three (3) days.

2. Technical user: One (1) day.

3. Maintenance user: Four (4) hours.

4. The Contractor shall include in his/her bid two (2) additional days of training for the 12-month period of the project warranty. The Contractor shall return to the site for additional follow-up training during this period.

END OF SECTION 27 41 00

SECTION 27 53 13.13 - WIRELESS CLOCK SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Master Transmitter
B. Twisted Pair GPS Antenna Cable Surge Suppression
C. Analog Clocks
D. Conduit
E. Non-Continuous Cable Hangers and Supports
F. Uninterruptible Power Supply

1.2 RELATED WORK

A. Section 26 05 33 - Conduit
B. Section 26 05 35 - Surface Raceways
C. Section 26 05 13 - Wire and Cable
D. Section 26 05 31 - Boxes
E. Section 27 05 00 - Basic Communications Systems Requirements
F. Section 27 05 26 - Telecommunications Grounding
G. Section 27 05 28 - Interior Communication Pathways
H. Section 27 05 53 - Identification and Administration

1.3 QUALITY ASSURANCE

A. Manufacturer: The manufacturer shall have five (5) years documented experience in the design and manufacture of wireless synchronized clock system devices and equipment.

B. Installer: The Contractor shall have a minimum of three (3) years documented experience in wireless synchronized clock system installation and must be a factory-authorized service and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.

1. The Contractor shall own and maintain all tools and equipment necessary for successful installation and testing of system and have personnel adequately trained in the use of such tools and equipment.

C. Service: The manufacturer of the system must have local service representatives within 60 miles of the project site.

D. The entire installation shall comply with all applicable electrical and safety codes. All applicable devices, equipment, and cabling shall be listed by Underwriters' Laboratories, Inc.

1.4 REFERENCES

A. ADA - Americans with Disabilities Act
B. ADAAG - Americans with Disabilities Accessibility Guidelines
C. FCC Title 47, Part 15 - Radio Frequency Devices
D. FCC Title 47, Part 74 - Experimental Radio, Auxiliary, Special Broadcast, and Other Program Distributional Services
E. FCC Title 47, Part 90 - Private Land Mobile Radio Services
F. NFPA 70 - National Electrical Code

G. TIA/EIA 526-18 - Systematic Jitter Generation Measurement
H. UL863 - Time Indicating and Recording Appliances

1.5 SUBMITTALS

A. Submit product data under the provisions of Section 27 05 00.

B. Product Data Submittal: 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.

2. All component options and accessories specific to this project.

3. Electrical power consumption rating and voltage.

4. Heat generation for all power consuming devices.

5. Wiring and connection requirements.

6. Manufacturer's installation instructions, indicating application conditions and limitations of use as stipulated by product testing agency and instructions for storage, handling, protection, examination, preparation, installation, and initiating usage of product.

C. System Drawings: Project-specific system CAD-generated drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical clocks), the diagram may show one device and refer to the others as "typical" of the device shown.

2. Where applicable, an equipment rack plan shall be provided showing rack elevations and dimensions in plan and elevation view. The plan shall include equipment layout within the rack.

D. Cable circuit or run, showing the drop for the specific circuit or run and cable size used.

E. Provide list of test equipment proposed for use in testing the installed wireless synchronized clock system.

F. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and installing Contractor.

2. Provide system checkout test procedure to be performed at acceptance, including demonstration of specified performance and all required system features and functions listed herein and as further detailed on the drawings.

G. Submit evidence of application for FCC Radio Station Authorization, if required. Application to be submitted in Owner's name by Contractor.

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.

1.7 SYSTEM DESCRIPTION

A. This section describes the products and execution requirements related to the furnishing, installation, commissioning, and programming of an extension of the existing American Time and Signal, wireless synchronized clock system.

B. Performance Statement: This specification section and the accompanying design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed or every equipment connection that must be made. Based on the equipment constraints 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, connections, programming, and miscellaneous equipment required for a complete and operational system.

C. Furnish and install a turnkey wireless synchronized clock system as hereinafter specified and further detailed on the drawings, complete with all necessary devices, sub-components, accessories, and incidental materials. Furnish all materials, labor, tools, and system commissioning necessary to complete the installation of the wireless synchronized clock system described in the Contract Documents.

D. Basic System Requirements: The system shall be capable of providing the following minimum features in addition to those specified elsewhere in this specification and on the drawings:

1. Wirelessly synchronize all clocks and all other wireless synchronized clock system devices throughout the facility to an external GPS time synchronization source.

2. Include an internal clock reference to be used in the event of a loss of external GPS time synchronization signal.

3. Automatically adjust for Daylight Saving Time in locations where Daylight Saving Time is observed.

4. Operate in accordance with all applicable FCC requirements.

5. Uninterruptible power supply to support continued system operation in the event of a loss of utility power.

1.8 OWNER FURNISHED PRODUCTS

A. PC to run wireless synchronized clock system configuration and scheduling software.

1. Coordinate exact PC requirements for manufacturer’s software with Owner prior to the commencement of work on site.

2. Any cabling required to connect and interface system device(s) to Owner's PC shall be furnished and installed by this Contractor.

1.9 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide floor plans identifying actual locations of all installed wireless synchronized clock system equipment and devices.

C. Provide final system block diagram showing any deviations from shop drawing submittal. Block diagram shall include cable number documenting the numbers installed on both ends of the cable in the field.

D. Provide documentation of all test results and statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described herein.

G. If required, deliver the original FCC Radio Station Authorization license to Owner prior to date of Substantial Completion of project.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 27 05 00.

B. Operation and Maintenance Data shall be submitted in hard copy and electronic .pdf format.

C. Operation Data shall include:

1. Manufacturer's full operation instructions for each piece of equipment.

2. Complete documentation of all settings and programming.

3. Detailed, step-by-step instructions for system operation, including accessing, initiating, and performing all required system features and functions listed herein.

D. Maintenance Data shall include:

1. Description of servicing procedures:

a. Documentation of all manufacturer's recommended preventive and remedial maintenance procedures to be performed by the Owner.

b. Troubleshooting flowcharts.

2. Spare parts list.

1.11 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Substantial Completion, as defined by the Contract. Certain system components may require additional manufacturer's warranty as described.

B. The warranty shall:

1. Ensure that all approved devices, equipment, cabling, and other components specified in this section meet or exceed the specified requirements.

2. Ensure against product defects.

3. Cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

4. Include emergency service and repair on-site, with response times of 24 hours from time of notification. The system shall be repaired and restored to operation within 24 hours of technician's arrival on site.

C. Refer to the individual product sections for further warranty requirements of individual system components.

PART 2 - PRODUCTS

2.1 MASTER TRANSMITTER

A. Features:

1. Receives GPS time signal and transmits wireless time synchronization signal to synchronized clock system clocks and other system devices wirelessly.
2. Complies with applicable FCC rules, UL standards, and EIA/TIA standards.
3. Contains internal clock to maintain operation in the event of a loss of GPS signal.
4. Outdoor-mounted GPS reception antenna.
5. Indoor-mounted transmit antenna.
6. LCD display.
7. Adjustable time zone and Daylight Saving Time settings.
8. Field programmable.
9. Non-volatile memory.

B. Specifications:

1. Time Input: GPS satellite signal.
2. Number of RF Transmit Channels: ≥ 10.
3. Power Input: 120 volt AC
4. Operating Temperature Range: 41°F to 122°F

C. Basis of Design: American Time and Signal (10-watt external transmit antenna)

D. Provide complete with:

1. GPS reception antenna and antenna cable.
2. External transmit antenna and antenna cable.
3. FCC Radio Station Authorization license issued directly to Owner, if required.
4. UPS to provide a minimum seven (7) days of battery backup.

2.2 TWISTED PAIR GPS ANTENNA CABLE SURGE SUPPRESSION

A. Features:

1. Protection Modes:

a. Line to line.
b. Line to ground.

2. Shielded RJ-45 female input and output connections.
3. Ground terminal.
4. Series connection.

B. Specifications:

1. Operating Voltage Range: 0 to 56 volts DC.
2. IEC 6100-4-5 Maximum Surge Current, Line to Line: ≥ 100 amps.
3. IEC 6100-4-5 Maximum Surge Current, Line to Ground: ≥ 1,500 amps.

C. Basis of Design: Transtector 1101-991.

D. Provide complete with same manufacturer's mounting bracket accessory.

E. .

2.3 SATELLITE TRANSMITTER / REPEATER

A. Features:

1. Receives wireless time synchronization signal from synchronized clock system master transmitter and repeats signal to remote clocks wirelessly.
2. Complies with applicable FCC rules, UL standards, and EIA/TIA standards.
3. Reception antenna.
4. Transmit antenna.

B. Specifications:

1. Power input: 120 volt AC.
2. Operating Temperature Range: 41°F to 122°F.

C. Basis of Design: Primex XR01R.

D. Provide complete with FCC Radio Station Authorization license issued directly to Owner, if required.

2.4 ANALOG CLOCKS

A. Features:

1. Circular high-impact polycarbonate frame and lens, black trim ring.
2. Surface mounted.
3. Dual-sided version can be wall mounted or ceiling mounted.
4. Battery operated.
5. Wireless synchronization.
6. Internal antenna.
7. Clock remembers time during battery changes and self-corrects upon restoration of power.

8. Automatically adjusts for Daylight Saving Time.
9. Functions as standard clock if synchronization signal fails, and automatically self-corrects to current time when synchronization signal resumes.

B. Specifications:

1. Size: 12” to 13” nominal diameter.
2. Clock Face Color: White.
3. Number Format: 12-hour with second hash marks.
4. Number Font: Black bold sans serif block-style.
5. Hand Colors: Black hour and minute hands, red second hand.
6. Operating Temperature Range: 41°F to 122°F.
7. Battery Life: ≥ 5 years.

C. Basis of Design

1. Single-sided: American Time and Signal SQ56BAAD604R.
2. Dual-sided: American Time and Signal SQ93BADD204.

D. Provide complete with battery pack(s), all necessary mounting hardware and accessories, and same manufacturer’s wire guard accessory where indicated on drawings.

2.5 CONDUIT

A. All conduit for synchronized clock system cabling shall be a minimum of 3/4” trade size. Provide larger-diameter conduit where required to accommodate size and number of cables and/or connectors on pre-connectorized cables.

B. Flexible conduit shall not be installed for any synchronized clock system cabling.

C. Refer to Section 26 05 33 for additional requirements.

2.6 NON-CONTINUOUS CABLE HANGERS AND SUPPORTS

A. Refer to Section 27 05 28 for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with all manufacturer’s instructions and recommendations for installation of all equipment, devices, and materials.

B. It is the Contractor’s responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. Wiring:

1. Refer to Section 26 05 33 for conduit requirements and Section 26 05 13 for wiring requirements. Wiring not installed in conduit shall be plenum rated.

2. All cabling shall be run in conduit “free-air” in non-continuous cable supports or cable tray above accessible ceilings, and in conduit or in a secured metal raceway in exposed areas. Supports shall be spaced at a maximum 4-foot

interval. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.

3. All wireless synchronized clock system antenna cabling shall be installed in its own cable pathway and shall not share any raceway or cable pathway with telephone or computer network cabling or cabling of any other system. Maintain a minimum of 39 inches of separation between antenna cabling and telephone or computer network cabling or cabling of any other system.

4. Cable shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires. Cables shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, ceiling supports, electrical or communications conduit, or structural elements.

5. Manufacturer's minimum bend radius specifications for cables shall be observed in all instances.

6. All cable shall be installed at right angles and be kept clear of work by other trades. To reduce or eliminate EMI, the following minimum separation distances from $\leq$ 480V power lines shall be adhered to:

   a. 12 inches from power lines of $<$5-kVa.
   b. 18 inches from high voltage lighting (including fluorescent).
   c. 39 inches from power lines of 5-kVa or greater.
   d. 39 inches from transformers and motors.

7. All cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

8. All cable shall be free of tension at both ends.

9. Both ends of all cables shall be clearly labeled with an alphanumeric identifier unique to that cable as to the system the cable is part of and the signal it carries. Record all cable identifiers on record drawings.

10.

D. Equipment:

1. All necessary devices, sub-components, accessories, and incidental materials required to provide a complete, turn-key wireless synchronized clock system that provides specified performance and all required system features and functions listed herein and as further detailed on the drawings shall be provided and installed as part of a complete system.

2. Install all head end equipment and devices in a manner that allows ample air flow for cooling.

3. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tools recommended by the manufacturer for that purpose. Use caution to avoid stripping or damaging connectors, terminals, or equipment by over-tightening termination fasteners.

4. Coordinate penetration of roof and wall membranes for external antenna cabling with Roofing Contractor and General Contractor as applicable to ensure all penetrations are made weatherproof.

5. If system requires an FCC license, program the call sign assigned by the FCC into the transmitter, configure the transmitter to operate on the frequency listed on the FCC license, and complete all FCC compliance paperwork.

6. Where more than one clock power supply is installed, equally distribute load between all clock power supplies.

7. Coordinate precise locations and termination of 120 volt AC power connections for clocks with Electrical Contractor prior to commencement of rough-in work on site.

8. Clocks shall not be installed until painting and all other finish work in each room has been completed and rooms are clean and dry.

9. Install all clocks plumb, level, and tight to the mounting surface.

10. Set each clock to display the correct, synchronized time.

11. Install wire guards centered on clocks and plumb, level, and tight to the mounting surface. Secure wire guards with theft-resistant fasteners.

12. At completion of project, clean exposed surfaces of all installed wireless synchronized clock system clocks in accordance with manufacturer's recommended cleaning methods.

E. Grounding Requirements:

1. Furnish and install dedicated minimum #6 AWG bonding conductors from antenna surge protector(s) and from master transmitter to the nearest wall-mounted telecommunications grounding busbar. Actual bonding conductor size determined by its length; refer to Section 27 05 26 for grounding and bonding conductor sizing criteria.

2. Audio cable shields for line level signals shall be connected to the metal equipment chassis at both ends of the cable. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.

3.2 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

C. Periodic observations will be performed during construction to verify compliance with the requirements of the project documents. These services do not relieve the Contractor of responsibility for compliance with the project documents.

3.3 SYSTEM SETUP, PROGRAMMING, AND ADJUSTMENT

A. The Contractor shall provide all system programming, start-up, calibration, and adjustment required as part of this project. This shall include all calibration and

adjustments of equipment controls, troubleshooting and final adjustments that may be required.

B. Complete all necessary programming to provide the specified features and functionality.

C. Program full, year-round schedule, including one (1) standard day and six (6) alternate day schedules per schedule and parameters furnished by Owner.

3.4 TESTING

A. The Contractor shall conduct all system testing as part of the requirements of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments or corrective action that may be required to provide a complete system that provides the specified performance and all required system features and functions listed herein and as further detailed on the drawings.

B. At a minimum, the installer shall perform the following inspections and tests of the installed overhead paging system:

1. Verify that all features and functionality are operating properly.

2. Verify that the system receives signal from external time synchronization source and synchronizes all system clocks and devices as specified.

3. Verify that each system clock and device receives proper synchronization signal.

4. Verify that each system clock displays the correct synchronized time.

5. Verify that each clock self-adjusts to display correct, synchronized time upon reception of valid synchronization signals.

6. Verify that all controls are properly labeled and interconnecting wires and terminals are identified.

C. Document all test results and submit as part of final system documentation package.

3.5 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.

B. Provide two week's advanced notice of training to the User.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:

1. Users:

a. Provide training on the system functions and operations that a daily user will encounter, including navigation of the user interface to accomplish all common operations.

2. Maintenance Staff

a. Provide training on the system functions and operations that a daily user will encounter, including navigation of the user interface to accomplish all common operations.

b. Provide training on all system components and the basic configuration of the system.

c. Identify and describe preventive and remedial maintenance procedures to be performed by the Owner.

d. Review troubleshooting flow charts and describe troubleshooting procedures for common issues.

E. Minimum on-site training times shall be:

1. Users: Two (2) hours.

2. Maintenance Staff: Four (4) hours.

END OF SECTION 27 53 13.13

SECTION 28 08 00 - COMMISSIONING OF ELECTRONIC SAFETY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commissioning is the process for ensuring that the electronic safety system is installed and performs interactively according to the basis of design criteria and meets the building operational performance expectations as defined in the sequences of operations. The process also provides adequate documentation of installation, start-up and functional testing and ensures that the Owner's maintenance personnel are adequately trained. It provides for discovery of system operational performance deficiencies prior to substantial completion while the responsible contractors can provide a timely response. It establishes testing and communication protocols in an effort to advance the Fire Alarm System from installation to complete dynamic operation and optimization.

B. The commissioning process involves all the parties involved in the design and construction process as well as the Owner and the Commissioning Provider (CxP). Primary elements of Commissioning during the construction, acceptance and warranty phases of the project include:

1. Verify applicable equipment and systems are installed in accordance with manufacturers' instructions and contract documents and receive adequate operational start-up checkout by installing contractors.
2. Demonstrate functional operational performance of equipment and systems in the commissioning program.
3. Verify O&M documentation submitted is complete. Provide required documentation and information to the General Contractor. Verify Owner's maintenance personnel are adequately trained in accordance with specified training plan requirements.
4. Verify systems are interacting and performing optimally in accordance with the system sequence of operations.
5. Furnish labor and material to accomplish electronic safety system commissioning and systems' testing as specified herein and other related sections.

1.2 RELATED SECTIONS

A. Section 01 9113 - General Commissioning Requirements.

B. Section 01 9114 - Functional Testing Requirements

C. Division 28 Sections pertaining to the Electronic Safety systems included in the commissioning program.

1.3 SUBMITTALS

A. Refer to Section 01 91 13 for commissioning submittal requirements. Provide copies of commissioning submittal requirements to the CxP, in addition to the copies required by the Owner and Design Professional.

1.4 COORDINATION

A. The installation schedule for the components, equipment & systems included in the commissioning program shall be such that the commissioning requirements can be met without impacting the construction schedule. Commissioning Functional Performance Testing is a requirement for Substantial Completion.

B. All maintenance points for components installed by the contractor (or sub-contractors) for building systems servicing shall be flagged utilizing construction marker ribbons if the

maintenance point is located where multiple trades will be installing systems, unobstructed access from floor level shall be maintained. Refer to Section 01 91 13 for additional information on maintenance/service point access.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Trade contractors shall provide all specialized tools, test equipment, and instruments required to execute startup, checkout, field calibration and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy (great accuracy than specified for component) to test and/or measure system performance according to specified tolerances. Test equipment is to have calibrated within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be re-calibrated when dropped or damaged. Calibration tags shall be affixed or certificates be readily available.

C. Datalogging equipment or software required to test equipment will be provided by the CxP, but shall not become the property of the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING

A. General Requirements. For additional information regarding general commissioning requirements refer to Section 01 91 13.

B. Installation contractors shall be responsible for executing and documenting equipment installation, start-up and check out for systems and equipment. Contractors shall also be responsible for executing and documenting prefunctional performance tests. Both of these documents are required prior to the CxP scheduling the functional performance test. Contractors shall also be responsible for providing training for the Owner's maintenance personnel in accordance with project requirements.

C. Installation Certification Forms (ICF) for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractors in documenting the installation and start-up of equipment in the commissioning program.

D. For equipment and system components requiring a manufacturer's representative for installation verification and start-up, manufacturer documentation of these activities shall be attached to the installation certification forms provided by the CxP.

E. Prefunctional Performance Test procedures for each type of equipment and system shall be provided to the installation contractors by the CxP for use by the contractor in documenting the performance of the prefunctional performance test. Refer to Section 01 9114 for further information.

F. Completed Start-up checklists and prefunctional performance test documentation for all pieces of equipment shall be submitted by contractors to the CxP through the General Contractor prior to the scheduling of the final Functional Performance Test that is witnessed by the Fire Marshal. The CxP may elect to witness the test along with the Fire Marshal or separately.

3.2 TRAINING

A. Contractor responsible for the installation of the system shall coordinate the participation of other sub-contractors and manufacturer's representatives in the training program in accordance with requirements of other sections of the project specifications.

3.3 OPERATIONS AND MAINTENANCE DATA

A. Contractor responsible for the installation of the system shall provide operations and maintenance manuals in accordance with requirements of other sections of the project specifications.

3.4 GENERAL SYSTEM TESTING CRITERIA

A. Functional Performance Testing

1. Refer to Sections 01 91 13 - General Commissioning Requirements and 01 9114 - Functional Testing Requirements. Installation contractor shall be responsible for providing authorized manufacturer's representatives to demonstrate the operational capabilities of the equipment & systems.

END OF SECTION 28 08 00

SECTION 28 31 00 - FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fire alarm and detection systems

B. Emergency Communications System with voice notification within-building, wide-area, and distributed recipient coverage.

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years experience.

B. 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.

C. 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 under provisions of Section 26 05 00 and as noted below.

1. Failure to comply with all of the following and all of the provisions in 26 05 00 will result in the shop drawing submittal being rejected without review.

2. 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 product catalog data sheets as shop drawings.

1. Provide a product catalog data sheet for each item shown on the General Electrical Equipment Schedule and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.

2. Where a particular General Electrical Equipment Schedule item has one or more variations (such as those denoted by subscripts, etc) a separate additional

product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding General Electrical Equipment Schedule symbol shall be shown on the top of each sheet.

3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.

C. Submit CAD floor plans as shop drawings:

1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer's wiring requirements shall be shown.

2. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.

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 installation and maintenance manuals under provisions of Section 26 05 00.

F. Submit manufacturer's certificate that system meets or exceeds specified requirements.

G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.

H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.

I. When required to comply with local or state regulatory reviews, 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 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 05 00.

B. Store and protect products under provisions of Section 26 05 00.

1.6 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.

1.7 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. Interfacing the existing fire alarm system: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to interface the existing fire alarm system with the new 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 interfaced with the new fire alarm system 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. Extending the existing Honeywell fire alarm system: The existing control panel shall remain and shall be operational throughout construction. The system shall only be disabled to make new connections and to modify the programming. A fire watch shall be provided for all areas affected during outages. All system outages must be scheduled with the Owner at least one week prior. Individual devices may be disabled as needed based on construction activities to reduce the potential for false alarms, but all devices must be operational when the Contractor is not physically on site. New initiating devices may be connected to the existing signaling line circuits where capacity is available. Provide additional signaling line circuits as needed based on existing and new device quantity, including replacement of existing panel components. Provide new notification circuits to serve the new devices, including all necessary power supplies, amplifiers, batteries, and 120 volt input circuits. All new devices shall be programmed to provide the same sequence of operation as the existing devices of the same type, unless noted otherwise.

E. 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.

F. Network: A complete fire alarm system network shall be provided. Provide quantity of control panels as indicated on the drawings. The network shall be a Style 7 token ring, peer-to-peer network. The network shall be characterized by simultaneous or sequential transmission, or both, and reception of multiple signals on a signaling line circuit or communication channel. The distributed intelligent characteristic of the network shall provide for all nodes independently making pertinent system decisions with no need for a central controller. Each node shall be capable of independent operation should loss of network communications occur. In no case shall read-only network annunciation be acceptable as the only networking function.

G. Voice Communication: The facility shall have an emergency voice alarm communication system. The digitized recorded voice message shall notify occupants that a fire condition has been reported. Emergency manual voice override shall be provided.

H. Emergency Communication System (ECS): A system 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 shall provide alerting in the building, wide-area notification on the campus and interface with distributed recipient mass notification system.

I. 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.

J. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.

K. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.

L. 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.

1.8 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 26 05 00.

B. Include location of end-of-line devices.

C. 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.

D. 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.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 26 05 00.

B. Include operating instructions, and maintenance and repair procedures.

C. Include results of testing of all devices and functions.

D. Include manufacturer’s representative's letter stating that system is operational.

E. Include the CAD floor plan drawings.

F. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

1.10 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. Honeywell XLS 1000

2.2 **[FAP-1]:** FIRE ALARM CONTROL PANEL (FAP)

A. Control Panel: Modular, power-limited electronic design. Provide surface wall-mounted enclosure as shown on plans. Enclosure shall be minimum 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.

B. Panel shall be provided with integral voice evacuation equipment (amps, etc.) to match the existing main fire alarm panel in the campus command center. Voice messages should be the same as used elsewhere in the campus. The fire alarm panel should have a microphone and selector switches for each pre-recorded message.

C. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer's system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop. The minimum system capacity shall be as follows:

Minimum Total Addressable Points:	250
Minimum Total SLC loops (including board, ready for field connections):	4
Panel Expansion Capability, Minimum Total SLC loops:	10
Minimum Node capacity for Network System:	100

D. Signal Line Circuit Board (SLC):

1. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions. Analog signals would be used for automatic test and determination of maintenance requirements.

2. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.

3. Class B, Style 4: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.

E. Notification Appliance Circuit (NAC) Board:

1. Each board shall contain its own microprocessor and shall be provided to control each notification appliance circuit. The board shall communicate and provide power to all devices on its loop.

2. Class B, Style Y: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.

F. Central Processing Unit:

1. The central processing unit (CPU) shall communicate with the monitor and control all other modules in the panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the CPU.

2. The CPU shall execute all control-by-event programs for specific action to be taken if a designated situation is detected in the system. A real-time system clock for time annotations on the display and printer shall be included.

3. All power for the unit shall be supervised and supplied by the FAP.

G. Display:

1. The board shall provide all controls and indicators used by the system operator and may also be used to program all control panel parameters.

2. The board shall provide an alphanumeric array for display of custom alphanumeric labels for all addressable points. It shall also provide indicators for AC Power, System Alarm, System Trouble, Display Trouble and Signal Silence.

3. Displayed descriptions of addressable points shall include actual room names/numbers selected by the Owner. This information shall be obtained prior to programming. Room names/numbers shown on floor plans shall not be used.

4. The board shall provide a touch key-pad with control capability to command all system functions and entry of any alphanumeric information. Twenty different passwords with four levels of security shall be supported to prevent unauthorized manual control or programming.

H. Memory: The CPU and display interface board shall be augmented by non-volatile field programmable memory. EPROM memory will also be allowed provided the memory is burned in with minimum expansion capability equal to the total system capacity of the panel. Memory shall not be lost upon primary and secondary power failure.

I. Power Supply:

1. Input power shall be 120 VAC, 60 Hertz. Output power shall be as noted on the device specifications and drawings. Each component of the fire alarm system requiring 120 VAC input power shall be served from a dedicated life safety branch circuit. Provide two #12 conductors and one #12 ground in 3/4" conduit to a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Identify/label breaker and branch circuit in accordance with NFPA requirements and Specification Section 26 05 53.

2. Adequate to supply 125% of all control panel and peripheral power needs as well as 125% of power required for all external audio-visual devices. The power

supply may be increased as needed by adding additional modular expansion power supplies. Over-current protections shall be provided on all power outputs.

3. All power supplies shall be designed and installed to meet UL and NFPA requirements for power-limited operation on all external initiating and indicating circuits.

4. The power supply shall provide integral charger for use with internal batteries. Battery capacity shall be sufficient 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.

J. Surge Protection:

1. The fire alarm control panel shall be furnished with an integral surge protection device (SPD). Refer to 26 43 00. It may be installed in an external cabinet as recommended by the manufacturer. In any case, the SPD must be connected upstream of any fire alarm equipment connections through a disconnect switch using #12 conductors maintained as short and as straight as possible.

2. Any communications or signaling circuits associated with the fire alarm system, which leave or enter a facility, shall be provided with a surge protection device. The devices shall be as recommended by the fire alarm system manufacturer.

2.3 SIGNALING LINE CIRCUIT DEVICES

A. **[FA-120]:** 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 32ºF and/or above 120ºF, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32ºF and 120ºF.

8. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Recall, SD=Smoke Dampers.

B. **[FA-122]:** 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. Provide a remote alarm LED indicator device (FA-240/241) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.

C. Manual Pull Stations:

1. Manual stations shall match the description on the drawings (refer to the General Electrical Equipment Schedule). The stations shall be mounted where shown on the drawings and be provided with all necessary mounting hardware. Use surface mount only on precast concrete or structure. WG subscript indicates wire guard is required.

2. **[FA-130]**: Addressable, double action with plastic breakrod, 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 32ºF and/or above 120ºF, a conventional device shall be installed with a unique monitor module located in the nearest available location, with maintained temperatures between 32ºF and 120ºF.

D. Heat Detectors:

1. **[FA-140]:** Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135ºF and at 15ºF 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. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area as shown on the drawings.

4. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.

5. Provide a remote LED indicator device if detector is not visible from a floor-standing position.

6. 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.

7. A test means shall be provided to simulate an alarm condition.

8. 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-160]:** 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-161]:** 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: Red housing with white lettering or pictogram.

2. Ceiling Mounted: White housing with red lettering or pictogram.

3. WG subscript indicates wire guard is required.

B. Visual Alarm Devices:

1. **[FA-200]:** Wall mounted.

2. **[FA-201]:** 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. **[FA-230]:** Audio (Speaker) Alarm Devices - Ceiling Mounted:

1. 4" speaker, round housing, flush mounted (provide tile bridge where applicable).

2. 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.

3. Speakers shall clearly reproduce a signal consisting of a live or prerecorded human voice and background music with voice intelligibility.

4. Speaker, housing, and backbox shall be UL listed for fire alarm/emergency applications.

D. Combination Audio (Voice) and Visual Notification Device:

1. **[FA-211]**: Wall mounted.

2. **[FA-231]**: Ceiling mounted.

3. Combine speaker and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.

E. **[FA-232]:** Audio (Speaker) Alarm Devices – High dB – Ceiling Mounted:

1. High dB suitable for 30 foot high ceiling application.

F. **[FA-233]:** Audio/Visual Alarm Devices – High dB – Ceiling Mounted:

1. High intensity strobe, 110 candela rating, high dB suitable for 30 foot high ceiling application.

G. **[FA-212]:** Weatherproof Audio/Visual Notification Device:

1. Electronic horn with high intensity strobe, square housing, 75 candela rating, suitable for wet locations. Provide with weatherproof back box.

2. Mounting: Semi-flush wall.

3. Conduit shall not be exposed.

2.5 **[NEP-#]:** NAC EXTENDER PANELS (NEP)

A. As shown on the plans or as a Contractor's option if not shown, 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 circuit. Provide two #12 conductors and one #12 ground in 1/2" 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 janitor closets or in locations coordinated with the Architect/Engineer.

E. Mounting: Surface.

2.6 ANNUNCIATION

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. Mounting: Flush.

5. The annunciator panel shall be provided with selector switches for each JJC standard pre-recorded message.

B. **[FA-241]**: Fire Alarm Remote Indicator:

1. Red LED type.
2. Mounts flush to a single gang box.

2.7 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

A. **[FA-250]**: Smoke Damper:

1. Motorized type, 120 VAC, furnished and installed by MC. Fire alarm control and power connections by EC. A subscript is used to identify the device with a

specific air handler or zone for its sequence of operation. Refer to the Operation Matrix and these specifications for complete requirements.

B. **[FA-251]**: Smoke or Fire/Smoke Damper Controller:

1. Provide an enclosure and equipment for interface of dampers with the fire alarm system and temperature control system.

C. **[FA-260]**: 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. Furnished and installed and MC; wired by EC.

D. **[FA-261]**: 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. Furnished and installed by MC; wired by EC.

E. **[FA-263]**: Electronic Bell:

1. Electronic bell for sprinkler alarm, electro-mechanical type, 120 VAC. Furnished and installed by MC. Fire alarm control and power connections by EC.

2.8 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.

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 via addressable relays tied to contact monitors on the 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. Fire Protection Electric Sprinkler Bell Sequence:

1. The fire alarm shall utilize an addressable relay to energize the electric sprinkler bell upon activation of the flow switch.

F. Smoke Damper Control Sequence:

1. The fire alarm system shall utilize an addressable relay to open the power connection to smoke or fire/smoke dampers and allow them to close. Coordinate other requirements with damper installer.

2. Where a damper is located in a main air duct, where closure of that single damper will entirely block airflow in the duct system, the smoke damper sequence shall also initiate the AHU shutdown sequence for the affected unit.

3. The AHU shutdown sequence shall be initiated only when ALL of the dampers associated with that unit are closed. Otherwise, the AHU shall continue to serve other areas.

4. Smoke and fire/smoke dampers located in branch ductwork shall be closed individually or in groups, as identified on the plans.

G. AHU Shutdown Sequence:

1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers. Coordinate other requirements with HVAC installer.

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.

H. 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.

I. 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. Fire Alarm Control Panel:

1. Install the control panel where shown on the drawings.

2. All expansion compartments, if required, shall be located at the control panel.

C. 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 adjust

location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.

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.

   c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.

7. Notification Appliance Devices:

   a. Devices shall be located where shown on the drawings.

   b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.

   c. Where ceiling mounted visual alarm devices or combination audio/visual alarm devices are shown where the ceiling is greater than 30'-0" high,

they shall be stem mounted so that the entire unit is below 30'-0". This does not apply to audio-only alarm devices.

D. Annunciators:

1. Remote Annunciators: The annunciators shall be located where shown on the drawings and approved by the fire marshal.

E. 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. 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. Notification Appliance Circuits shall not span floors or smoke compartments.

7. Signal line circuits connecting devices shall not span floors or two-hour smoke compartments.

8. 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 with "E-Z Markers" or equivalent. 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.

F. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows, or using colored tape at each conductor termination and in each junction box.

1. Power branch circuit conductors: In accordance with Section 26 05 53.
2. Signaling line circuit: Overall red jacket with black and red conductors.
3. DC power supply circuit: Overall red jacket with violet and brown conductors.
4. Notification appliance circuit: Overall red jacket with blue and white conductors.
5. Door release circuit: Gray conductors.
6. Central station trip circuit: Orange conductors.

7. Central station fire alarm loop: Black and white conductors.

G. 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.

H. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 05 00.

B. 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.

C. 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 or equal to 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.

d. As specified on the drawings.

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. Final ambient sound measurements shall be taken during occupancy and the units shall be re-adjusted at that time, if necessary.

e. All sound level measurements shall be taken at a height of 5' above the finished floor level.

f. 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.

g. 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.

h. 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.

D. Additionally test the voice alarm communication system intelligibility per IEC 60849:

1. The following acoustically distinguishable spaces shall be tested: Field House.

2. Utilize equipment designed to test per IEC 60849 per the equipment manufacturer's instructions. This equipment includes a signal generator, which is input to the fire alarm system and a portable measurement device. This equipment is available from Simplex Grinnell or Gold Line.

3. Testing equipment that can simulate 'crowd babble' shall be used in rooms with occupancy of greater than 200.

4. When testing for intelligibility, the quantity and location of the measurement points shall be the same as the points used for measurement of dBA level.

5. Provide a report, showing the average dBA level and STI for the Field House. The report shall be presented to the Architect/Engineer in an Excel .xls file.

3.4 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services under provisions of Section 26 05 00.

B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.

C. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. The Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner 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.

3.5 SYSTEM TRAINING

A. System training shall be performed under provisions of Section 26 05 00.

B. Minimum on-site training times shall be:

1. System Operators: One (1) day.
2. Emergency Communication System: Four (4) hours.

END OF SECTION 28 31 00