

PROJECT MANUAL



County of Kenosha
4777 88th Ave
Kenosha, WI 53144

Kenosha County Detention Center Rooftop Equipment Replacement Phase 1

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Issued for Bid

Clark Dietz: Project No. K0450060

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SECTION 00 00 10

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KENOSHA, WI

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END OF SECTION

SECTION 01 10 00

SUMMARY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Related Documents.
- B. Contract Description.
- C. Scheduling of Work.
- D. Construction Schedule.
- E. Construction Sequence.
- F. Contractor's Use of Site.
- G. Owner Occupancy.
- H. Specification Conventions.

1.2 RELATED DOCUMENTS

- A. Documents related to the Work include:
 - 1. Contract Drawings
 - 2. General Provisions of the Contract including General and Supplementary Conditions
 - 3. All other Sections included herein as part of the Project Manual
 - 4. Addendum to the Drawings and Project Manual issued during Bidding

1.3 CONTRACT DESCRIPTION

- A. Work of the Project includes the following:
 - 1. Selective demolition and disposal.
 - 2. Replace existing rooftop equipment and VAV boxes with new equipment. Make all required piping, ductwork and electrical connections to the new equipment. Provide new controls for all equipment replaced as part of this project.
 - 3. Integrate existing fire alarm devices into new equipment where equipment replacement occurs.
- B. The Contract Documents indicate the Work of the contract and related requirements and conditions that have an impact on the Work. Related requirements and conditions that are indicated on the Contract Documents include, but are not necessarily limited to the following:
 - 1. Existing site conditions and restrictions on use of the Site.

1.4 SCHEDULING OF WORK

- A. Scheduling of Work
 - 1. With the exception of work listed in this Section, the Contractor may schedule his work in any manner he deems appropriate to complete the contract within the time allowed. The Contractor is cautioned that some of the work may have to be performed during other than normal working hours and that the Owner may revise the schedule whenever the Owner finds it necessary to maintain work progression, or to protect the Owner's facility, or to maintain continuous, satisfactory operation of existing facilities.
 - 2. Following is an anticipated project schedule. Contractor will be responsible for providing an update schedule once notice to proceed has been awarded.
 - a. Contract Award – By 05/31/2021
 - b. Construction Shop Drawings/Review – By 06/16/2021
 - c. Pre-Construction Meeting – 08/24/2021
 - d. Mobilization – 09/06/21- 09/10/21
 - e. Substantial Completion – 03/31/22
 - f. Final Completion – 05/31/22
 - 3. The Contractor shall submit a Construction Progress Schedule at every progress meeting.

4. The Contractor is responsible for the means and methods necessary to accomplish the work in compliance with the specified criteria. Access must be maintained for personnel and equipment to enter and maintain the facility at all times. All shutdowns must be coordinated with the Owner a minimum of 72 hours prior. All shutdowns must occur during low flow periods as defined by the Owner.

B. Coordination with Others

1. The Owner will attempt to keep the Contractor informed of changes to existing contracts and award of subsequent contracts that may affect the Contractor. Schedules of operations for other contractors working will be made available to the Contractor upon request.

1.5 CONSTRUCTION SCHEDULE

- A. The work described in this Section shall be shown in the Construction Progress Schedule. All construction steps, procedures and temporary facilities shall be approved by the Owner prior to implementation by the Contractor. The monthly updates of the Schedule of Construction shall show any changes in the proposed work, including proposed shutdown work.
- B. The completion schedule for this contract requires timely transmittal of contract submittals for review by the Engineer. The identification and transmittal of all submittals required for completion of the phase of work described above is the Contractor's responsibility.
- C. The Contractor shall be held responsible for all direct and indirect delays resulting from the Contractor's failure to identify and transmit the submittals required to successfully complete the contract work within the time specified.
- D. The following early submittals shall be submitted within ten days after Notice to Proceed:
 1. Construction Schedule
 2. Health and Safety Plan
 3. Site Security plan/requirements

1.6 CONSTRUCTION SEQUENCE

- A. To be determined

1.7 CONTRACTOR'S USE OF SITE

- A. Limit use of site and premises to allow Owner occupancy.
- B. Construction Operations: Construction operations to be coordinated with the Owner.
- C. Time Restrictions for Performing Work: Work hours are to be coordinated with the Owner.
- D. Utility Outages and Shutdown are to be coordinated with the Owner.

1.8 OWNER OCCUPANCY

- A. The Owner will occupy the premises during the entire period of construction for the conduct of normal operations.
- B. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.
- C. Schedule the Work to accommodate Owner occupancy.

1.9 SPECIFICATION CONVENTIONS

- A. These specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words “shall be” are included by inference where a colon (:) is used within sentences or phrases.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 29 76
PAYMENT PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Related documents
- B. Payment requests

1.2 PAYMENT REQUESTS

- A. General: Except as otherwise indicated, the progress payment cycle is to be regular. Each application must be consistent with previous applications and payments. Certain applications for payment, such as the initial application, the application at substantial completion, and the final payment application involve additional requirements.
 - 1. Waivers of Lien: For each payment application, submit waivers of lien from every entity (including Contractor) who could lawfully and possibly file a lien in excess of \$1,000 arising out of the Contract, and related to work covered by the payment. Submit partial waivers for the amount requested, prior to deduction or retainage, on each item. When the application shows completion of an item, submit final or full waivers. The Owner reserves the right to designate which entities involved in the work must submit waivers.
 - 2. Waiver Delays: Each progress payment must be submitted with Contractor's waiver for the period of construction covered by the application. At the Contractor's option, each progress payment may be submitted with waivers from the subcontractors or sub-subcontractors and suppliers for the previous period of construction covered by the previous application. The final payment application must be submitted together with or preceded by final or complete waivers from every entity involved with performance of the work covered by the payment request.
 - 3. Waiver Forms: Submit waivers on forms, and executed in a manner, acceptable to Owner.
 - 4. Sworn Statement: Each progress payment must be submitted with a sworn statement showing subcontractors and material suppliers and the payment status of each. Form of the sworn statement shall be subject to approval of the Owner.
- B. Payment Application Times: The "date" for each progress "payment" is as indicated in Owner-Contractor Agreement or, if none is indicated therein, it is the 15th day of each month. The period of construction work covered by each payment request is period indicated in Owner-Contractor Agreement or, if none is indicated therein, it is period ending 15 days prior to date for each progress payment, and starting day following end of preceding period. Dates shall be confirmed at the preconstruction meeting.
- C. Application Preparation: Except as otherwise indicated, complete every entry provided for on the form, including notarization and execution by authorized persons. Incomplete applications will be returned by Owner without action. Listing must include amounts of change orders issued prior to last day of the "period of construction" covered by application.
- D. Initial Payment Application: The principal administrative actions and submittals which must precede or coincide with submittal of contractor's first payment application can be summarized as follows, but not necessarily by way of limitation:
 - 1. Schedule of Values
 - 2. Schedule of Submittals (Section 01 33 00).
 - 3. Listing of Contractor's staff assignments.
 - 4. Waiver of Lien and Sworn Statement.

- E. Monthly Payment Application: The principal administrative actions and submittals which must precede or coincide with submittal of contractor's first payment application can be summarized as follows, but not necessarily by way of limitation:
1. Updated Schedule.
 2. Revised Schedule of Submittals (Section 01 33 00), if applicable.
 3. Updated listing of Contractor's staff assignments, if applicable.
 4. Waiver of Lien, Including Subcontractor Lien Waivers, and Sworn Statement.
- F. Application at Time of Final Completion: Following issuance of Owner's final "certificate of substantial completion", and also in part as applicable to prior certificates on portions of completed work as designated, a "special" payment application may be prepared and submitted by Contractor. The principal administrative actions and submittals which must proceed or coincide with such special applications can be summarized as follows, but not necessarily by way of limitation:
1. Warranties (guarantees), maintenance agreements and similar provisions of contract documents.
 2. Test records, maintenance instructions, start-up performance reports, and similar change-over information germane to Owner's occupancy, use, operation and maintenance of completed work.
 3. Final cleaning of the work.
 4. Application for reduction (if any) of retainage, and consent of surety.
 5. Advice to Owner on coordination of shifting insurance coverages, including proof of extended coverages as required.
 6. Listing of Contractor's incomplete work, recognized as exceptions to Engineer's certificate of substantial completion.
 7. Compact disc with project photos.
- G. Final Payment Application: The administrative actions and submittals which must precede or coincide with submittal of contractor's final payment application can be summarized as follows, but not necessarily by way of limitation:
1. Completion of project closeout requirements.
 2. Completion of items specified for completion beyond time of substantial completion (regardless of whether special payment application was previously made).
 3. Assurance, satisfactory to Owner, that unsettled claims will be settled and that work not actually completed and accepted will be completed without undue delay.
 4. Transmittal of required project construction records to Owner.
 5. Proof, satisfactory to Owner, taxes, fees and similar obligations of Contractor have been paid.
 6. Removal of temporary facilities, services, surplus materials, rubbish and similar elements.
 7. Consent of surety for final payment.
- H. Application Transmittal: Submit 3 executed copies of each payment application, one copy of which is completed with waivers of lien, sworn statement and similar attachments. Transmit each copy with a transmittal form listing those attachments, and recording appropriate information related to application in a manner acceptable to Owner. Transmit to Owner by means ensuring receipt within 24 hours.

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION – Not Used

END OF SECTION

SECTION 01 30 00

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Coordinating interruptions in Owner's operations.
- B. Coordination and project conditions.
- C. Special reports.
- D. Preconstruction meeting.
- E. Progress meetings.
- F. Weekly report.
- G. Cutting and patching.
- H. Special procedures.
- I. Cleaning and protection.
- J. Conservation.

1.2 COORDINATING INTERRUPTIONS IN OWNER'S OPERATIONS

- A. Show all anticipated operational interruptions of the Owner's facilities on the progress schedule.
- B. Coordinate all operational interruptions with the Owner at least 48 hours prior to commencing with the work. The Owner may require that the Contractor reschedule work as required to maintain the operation of their facilities.
- C. Except as specified herein, all operations must be maintained during construction. The Contractor is responsible for all, temporary electrical, and temporary communications that are necessary to continue the Owner's operation of their facilities.

1.3 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate scheduling, submittals, and Work of various sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify utility requirements and characteristics of operating equipment are compatible with utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.
- C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

- D. In finished areas except as otherwise indicated conceal pipes within construction.
- E. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion and for portions of Work designated for Owner's occupancy.
- F. During Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.
- G. Limitations on construction area usage as well as specific requirements that impact utilization are indicated by Contract Documents. Schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on construction area.

1.4 SPECIAL REPORTS

- A. Accident Reports: Prepare and submit reports of significant accidents, at site and anywhere else work is in progress. Record and document data and actions. For this purpose, a significant accident is defined to include events where personal injury is sustained, or property loss of substance is sustained, or where the event posed a significant threat of loss or personal injury.

1.5 PRECONSTRUCTION MEETING

- A. Engineer will schedule an initial progress meeting with the Contractor and Owner, recognized as the preconstruction meeting, after Notice of Award.
- B. The preconstruction meeting will be an organizational meeting. Agenda items may include:
 1. Execution of Owner-Contractor Agreement.
 2. Submission of executed bonds and insurance certificates.
 3. Distribution of Contract Documents.
 4. Submission of list of Subcontractors, list of products, schedule of values, and progress schedule.
 5. Designation of personnel representing parties in Contract and Engineer.
 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 7. Scheduling.
 8. Use of premises by Owner and Contractor.
 9. Owner's requirements.
 10. Survey and layout.
 11. Security and housekeeping procedures.
 12. Application for payment procedures.
 13. Procedures for testing.
 14. Procedures for maintaining record documents.
 15. Requirements for start-up of equipment.
 16. Inspection and acceptance of equipment put into service during construction period.

1.6 PROGRESS MEETINGS

- A. In addition to other project meetings held for other purposes, hold a general progress meeting with the Engineer and Owner throughout progress of the Work at weekly intervals.
- B. The schedule of the progress meetings will be determined during the preconstruction meeting. In general, progress meetings will be coordinated with preparation of the payment request.
- C. Review each entity's present and future needs including interface requirements, time, sequences, deliveries, access, site utilization, temporary facilities and services, hours of work, hazards and risks, housekeeping, change orders, and documentation of information for payment requests. Discuss whether each element of current work is ahead of schedule, on time, or behind schedule in relation with updated progress schedule. Determine how behind-schedule work will be expedited, and secure commitments from

entities involved in doing so. Discuss whether schedule revisions are required to ensure that current work and subsequent work will be completed within Contract Time. Review everything of significance which could affect progress of the work.

- D. Updating Schedules: Immediately following each progress meeting, where revisions to progress schedule have been made or recognized, revise and reissue progress schedule as described in Section 01 33 00.
- E. Attendance Required: Job superintendent, major subcontractors and suppliers, and others as appropriate to agenda topics for each meeting.
- F. Agenda:
 - 1. Review minutes of previous meetings, if applicable.
 - 2. Review of Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems impeding planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of off-site fabrication and delivery schedules.
 - 7. Maintenance of progress schedule.
 - 8. Corrective measures to regain projected schedules.
 - 9. Planned progress during succeeding work period.
 - 10. Coordination of projected progress.
 - 11. Maintenance of quality and work standards.
 - 12. Effect of proposed changes on progress schedule and coordination.
 - 13. Other business relating to Work.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 SPECIAL PROCEDURES

- A. Materials: As specified in product sections, match existing with new products for patching and extending work.
- B. Employ skilled and experienced installers to perform work.
- C. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion.
- D. Remove unsuitable material not marked for salvage. Replace materials as specified for finished Work.
- E. Remove debris and abandoned items from area and from concealed spaces.
- F. Prepare surface and remove surface finishes to permit installation of new work and finishes.
- G. Remove, cut, and patch Work in manner to minimize damage and to permit restoring products and finishes to original or specified condition.
- H. Refinish existing visible surfaces to remain in renovated rooms and spaces, to specified condition for each material, with neat transition to adjacent finishes.
- I. Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections.

J. Finish surfaces as specified in individual product sections.

3.2 CLEANING AND PROTECTION

- A. General: During handling and installation of work at the project site, clean and protect work in progress and adjoining work on the basis of continuous maintenance.
- B. Limiting Exposures of Work: To the extent possible through reasonable control and protection methods, supervise performance of the work in such a manner and by such means which will ensure that none of the work, whether completed or in progress, will be subjected to harmful, dangerous, damaging or otherwise deleterious exposure during the construction period. Such exposures include, where applicable, but not by way of limitation the following:
1. Water or ice.
 2. Solvents.
 3. Chemicals.
 4. Light.
 5. Puncture.
 6. Abrasion.
 7. Heavy traffic.
 8. Misalignment.
 9. Excessive weathering.
 10. Unprotected storage.
 11. Improper shipping or handling.
 12. Theft.
 13. Vandalism.

3.3 CONSERVATION

- A. It is a requirement for supervision and administration of the work that construction operations be carried out with the maximum possible consideration given to conservation of energy, water and materials.

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Submittal procedures.
- B. Owner's/Engineer's Action.
- C. Proposed products list.
- D. Product data.
- E. Shop drawings.
- F. Design data.
- G. Test reports.
- H. Certificates.
- I. Manufacturer's instructions.
- J. Operation and Maintenance manuals.
- K. Manufacturer's field reports.
- L. Construction photographs.

1.2 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Engineer accepted form to engineer and owner via email/online construction management program.
- B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
- C. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.
- D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of the Work and Contract Documents.
- E. Schedule submittals to expedite Project and deliver to Engineer as directed below for electronic submittals. Coordinate submission of related items.
- F. For each submittal review, allow 15 days excluding delivery time to and from Contractor. Where the submittal must be held for coordination, the Engineer will so advise the Contractor.

- G. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
- H. Allow space on submittals for Contractor and Engineer review stamps.
- I. When revised for resubmission, identify changes made since previous submission.
- J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- K. Submittals not requested will not be recognized or processed.
- L. Except for samples, electronic submittals are required.
- M. Electronic submittals are required to conform to all of the submittal requirements listed above.
- N. Email electronic submittals to the Engineer.
- O. Submit electronic documents as a single portable electronic file (.pdf). Contractor should request an exception for documents that are not sent in pdf format or are sent as multiple files. Electronic files will be rejected if they are not clearly legible.
- P. Submittals delivered electronically will be returned to the Contractor as electronic files. Engineer will return:
 - 1. Engineer's review form and comments
 - 2. Contractor's transmittal form
 - 3. Submittal materials only if comments on the materials are required.

1.3 OWNER'S/ENGINEER'S ACTION

- A. Unless otherwise noted, the Owner and Engineer will review each submittal and mark with appropriate "Action".
- B. Action Stamp: The Owner and Engineer will stamp each submittal to be returned with a uniform, self-explanatory action stamp, appropriately marked and executed to indicate whether the submittal returned is for unrestricted use, final-but-restricted use (as marked), must be revised and resubmitted (use not permitted) or without action (as explained on the transmittal form).
- C. Final Unrestricted Release: Where the submittals are marked as follows, the work covered by the submittal may proceed provided it complies with the requirements of the contract documents; acceptance of the work will depend upon that compliance.
 - 1. Marking: "No Exception Taken".
- D. Final-But-Restricted Release: When the submittals are marked as follows, the work covered by the submittal may proceed provided it complies with the Owner/Engineer's notations, corrections marked on the submittal, and with the requirements of the contract documents; acceptance of the work will depend on that compliance.
 - 1. Marking: "Make Corrections Noted".
- E. Returned to Resubmittal: When the submittal is marked as follows, do not proceed with the work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise the submittal or prepare a new submittal in accordance with the Owner/Engineer's notations stating the reasons for returning the submittal. Repeat if necessary to obtain a different action marking. Do not permit submittals with the following marking to be used at the project site, or elsewhere where work is in progress.
 - 1. Marking:
 - a. "Rejected".
 - b. "Revise and Resubmit".

- c. "Submit Specified Item."

1.4 PROPOSED PRODUCTS LIST

- A. Within 15 days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.5 PRODUCT DATA

- A. Information required specifically as product data includes manufacturer's standard printed recommendations for application and use, compliance with recognized standards of trade associations and testing agencies, and the application of their labels and seals (if any), special notation of dimensions which have been verified by way of field measurement, and special coordination requirements for interfacing the material, product or system with other work.
- B. Collect required product data into a single submittal for each unit of work or system. Mark each copy to show which choices and options are applicable to the project. Where product data has been printed to include information on several similar products, some of which are not required for use on the project, or are not included in this submittal, mark the copies to show clearly that such information is not applicable.
- C. Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents. Product data submittal is required for information and record and to determine that the products, materials and systems comply with the provisions of the contract documents. Therefore, the initial submittal is also the final submittal, except where the Engineer observes that there is non-compliance with the provisions of the contract documents and returns the submittal to the Contractor marked with the appropriate "Action".
- D. Unless submitted electronically, submit number of copies Contractor requires, plus three copies Engineer will retain.
- E. Identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- F. Where product data must be specially prepared for required products, materials or systems, because standard printed data is not suitable for use, submit data as "shop drawings" and not as "product data".
- G. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- H. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.6 SHOP DRAWINGS

- A. Shop Drawings: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- C. When required by individual specification sections, provide shop drawings signed and sealed by professional engineer responsible for designing components shown on shop drawings.
 - 1. Include signed and sealed calculations to support design.

2. Submit drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.

- D. Make revisions and provide additional information when required by authorities having jurisdiction.
- E. Information required on shop drawings includes, dimensions, identification of specific products and materials which are included in the work, compliance with specified standards and notations of coordination requirements with other work. Provide special notation of dimensions that have been established by field measurement. Highlight, encircle or otherwise indicate deviations from the contract documents on the shop drawings.
- F. Do not permit shop drawing copies without an appropriate final "Action" marking by the Engineer to be used in connection with the work.
- G. Unless submitted electronically, submit number of opaque reproductions Contractor requires, plus three copies Engineer will retain.
- H. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.7 DESIGN DATA

- A. Submit for Engineer's knowledge as contract administrator or for Owner.
- B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.
- C. Unless submitted electronically, submit number of opaque reproductions Contractor requires, plus three copies Engineer will retain.

1.8 TEST REPORTS

- A. Submit for Engineer's knowledge as contract administrator or for Owner.
- B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.
- C. Unless submitted electronically, submit number of opaque reproductions Contractor requires, plus three copies Engineer will retain.

1.9 CERTIFICATES

- A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Engineer, in quantities specified for Product Data.
- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Engineer.
- D. Unless submitted electronically, submit number of opaque reproductions Contractor requires, plus three copies Engineer will retain.

1.10 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer for delivery to Owner in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.11 MANUFACTURER'S OPERATION AND MAINTENANCE MANUALS

- A. Obtain installation, operation, and maintenance manuals from manufacturers and suppliers for each item of equipment furnished under the Contract. Submit three copies of each complete manual to the Owner within 90 days after approval of shop drawings, product data, and samples and not later than the date of shipment of each item of equipment to the project site.
- B. Manuals shall be provided for each piece of equipment including individual components and subsystems of complete assemblies. The section of the manual on operation shall describe the function of each component and its relationship to the system of which it is a part. Where several models, options, or styles are described, the manual shall identify the items actually provided.
- C. The manual shall contain the following:
 - 1. An 8-1/2 x 11 inch typewritten sheet listing the manufacturer's identification, including order number, model, and serial number and location of parts and service centers.
 - 2. A separate 8-1/2 x 11 inch typewritten list of recommended stock of parts, including part number and quantity.
 - 3. Complete replacement parts list and drawings.
 - 4. Performance data and rating tables.
 - 5. Specific instructions for installation, operation, adjustment, and maintenance.
- D. Each manual shall be bound in a folder and labeled to identify the contents and project to which it applies.
- E. Operation and maintenance manuals specified herein are in addition to any operation, maintenance, or installation instructions required by the Contractor to install, test, and start up equipment.

1.12 MANUFACTURER'S FIELD REPORTS

- A. Submit reports for Engineer's benefit as contract administrator or for Owner.
- B. Unless submitted electronically, submit two copies of the report within 5 days of observation to Engineer for information.
- C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.13 CONSTRUCTION PHOTOGRAPHS

- A. Take pre-construction digital photos as evidence of existing project. The photos shall be submitted prior to working in each room.
- B. With the application at time of Final Completion: Deliver compact discs with .jpg files to Owner with project record documents. Catalog and index files by room number.

1.14 SUBMITTAL SCHEDULE

- A. A proposed preliminary submittal schedule is attached to this Section.

B. Contractor shall submit his own Schedule of Submittals with the Initial Payment Application.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 40 00

QUALITY PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Quality control and control of installation.
- B. Tolerances.
- C. References.
- D. Labeling.
- E. Source and quality of materials and equipment.
- F. Examination.
- G. Preparation.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- H. After the installation is completed, contractor is responsible for assisting owner with equipment commissioning. The commissioning authority for this project consists of representatives from owner and engineer. The commissioning requirements are listed in various specifications and divisions.

1.3 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

- A. For products or workmanship specified by association, trade, or other consensus standards, complies with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

- B. Conform to reference standard by date of issue current on date for receiving bids, except where specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- E. Neither contractual relationships, duties, responsibilities of parties in Contract, nor those of Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

1.5 LABELING

- A. Attach label from agency approved by authority having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.
- B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label.
 - 1. Model number.
 - 2. Serial number.
 - 3. Performance characteristics.

1.6 SOURCE AND QUALITY OF MATERIALS AND EQUIPMENT

- A. The source of materials to be used shall be in accordance with the Contract Documents and as approved by the Engineer before delivery. The approval of the source of any material shall continue as long as the material conforms to the Specifications.
- B. All material not conforming to the requirements of the Specifications shall be considered as defective and shall be removed from the Work. If in place, faulty materials shall be removed by the Contractor at his expense and replaced with acceptable material unless permitted otherwise by the Owner. No defective materials which have been subsequently corrected shall be reused until approval has been given.
- C. Upon failure of the Contractor to comply immediately with any order of the Engineer to remove and replace defective material, the Owner shall have authority to remove and replace defective materials, and to deduct the cost of removal and replacement from any monies due or to become due to the Contractor. Failure to reject any defective materials or work at the time of installation shall in no way prevent later rejection when such defects are discovered, nor obligate the Owner to final acceptance.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Verify utility services are available, of correct characteristics, and in correct locations.

END OF SECTION

SECTION 01 42 16

DEFINITIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description of requirements.
- B. Definitions.

1.2 DESCRIPTION OF REQUIREMENTS

- A. This section specifies procedural and administrative requirements for compliance with governing regulations and codes and standards imposed upon the Work. These requirements include obtaining permits, licenses, inspections, releases and similar documentation, as well as payments, statements and similar requirements associated with regulations, codes and standards.
 - 1. The term "Regulations" is defined to include laws, statutes, ordinances and lawful orders issued by governing authorities, as well as those rules, conventions and agreements within the construction industry which effectively control the performance of the Work regardless of whether they are lawfully imposed by governing authority or not.
- B. Governing Regulations: Refer to General and Supplementary Conditions for requirements related to compliance with governing regulations.

1.3 DEFINITIONS

- A. General Explanation: Certain terms used in contract documents are defined in this article. Definitions and explanations contained in this section are not necessarily complete but are general for the Work to the extent that they are not stated more explicitly in another element of the contract documents.
- B. General Requirements: Provisions and requirements of other Division 01 sections apply to the entire work of the Contract and, where so indicated, to other elements which are included in the project.
- C. Indicated: The term "indicated" is a cross-reference to graphic representations, notes or schedules on the drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for the purpose of helping the reader locate the cross-reference, and no limitation of location is intended except as specifically noted.
- D. Directed, Requested, etc.: Terms such as "directed", "requested", "authorized", "selected", "approved", "required", "accepted", and "permitted" mean "directed by the Owner", "requested by the Owner", and similar phrases. However, no such implied meaning will be interpreted to extend the Owner's responsibility into the Contractor's area of construction supervision.
- E. Approve: Where used in conjunction with the Engineer's response to submittals, requests, applications, inquiries, reports and claims by the Contractor, the term "approved" will be held to limitations of the Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will the Engineer's approval be interpreted as a release of the Contractor from responsibilities to fulfill requirements of contract documents or acceptance of the Work, unless otherwise provided by requirements of the contract documents.
- F. Project Site: The term "project site" means the space available to the Contractor for performance of the Work, either exclusively or in conjunction with others performing other construction as part of the project or

other projects. The extent of the project site is shown on the drawings and may or may not be identical with the description of the land upon which the project is to be built.

- G. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations."
- H. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, applying, working to dimension, protecting, cleaning and similar operations."
- I. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
- J. Installer: The "installer" is "the entity" (person or firm) engaged by the Contractor, its subcontractor or sub-subcontractor for performance of a particular element of construction at the project site, including installation, erection, application and similar required operations. It is a requirement that installers are experienced in the operations they are engaged to perform.
- K. Testing Laboratories: A "testing laboratory" is an independent entity engaged to perform specific inspections or tests of the Work, either at the project site or elsewhere, and to report, and (if required) interpret results of those inspections or tests.
- L. Commissioning Agent/Authority: Assigned personnel that will work with contractors to ensure that building construction project meets the operational requirements of the client.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 42 19

REFERENCE STANDARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description of requirements.
- B. Specification format and content explanation.
- C. Drawing symbols.
- D. Industry standards.
- E. Governing regulations/authorities.

1.2 DESCRIPTION OF REQUIREMENTS

- A. This section specifies procedural and administrative requirements for compliance with governing regulations and codes and standards imposed upon the Work. These requirements include obtaining permits, licenses, inspections, releases and similar documentation, as well as payments, statements and similar requirements associated with regulations, codes and standards.
 - 1. The term "Regulations" is defined to include laws, statutes, ordinances and lawful orders issued by governing authorities, as well as those rules, conventions and agreements within the construction industry which effectively control the performance of the Work regardless of whether they are lawfully imposed by governing authority or not.
- B. Governing Regulations: Refer to General and Supplementary Conditions for requirements related to compliance with governing regulations.

1.3 SPECIFICATION FORMAT AND CONTENT EXPLANATION

- A. General: This article is provided to help the user of these specifications more readily understand the format, language, implied requirements and similar conventions of content. None of the following explanations shall be interpreted to modify the substance of contract requirements.
 - 1. Production Methods: Portions of these specifications have been produced by editing master specifications and the standard specifications covenants applicable to construction; they may contain minor deviations from traditional writing formats. Such deviations are a natural result of this production technique, and no other meaning shall be implied.
- B. Specification Format: These specifications are organized based upon the Construction Specifications Institute's 48-Division format. The organization of these specifications into Divisions, Sections or Trade Headings conforms generally to recognized industry practice.
- C. Specification Content: This project specification has been produced employing certain conventions in the use of language as well as conventions regarding the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:
 - 1. In certain circumstances, language used in specifications and other contract documents is of the abbreviated type. Implied words and meanings will be appropriately interpreted. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where the full context of the contract documents so indicates.
 - 2. Imperative Language is used generally in the specifications. Requirements expressed imperatively are to be performed by the Contractor. At certain locations in the text, for clarity, contrasting subjective language is used to describe responsibilities which must be fulfilled indirectly by the Contractor, or by others when so noted.
- D. Methods of Specifying: Techniques or methods of specifying requirements vary throughout the text. The method used for specifying one element of the Work has no bearing on requirements for another element of the Work.

- E. Assignment of Specialists: In certain circumstances, the specification requires or implies that specific elements of the Work are to be assigned to specialists who must be engaged to perform that element of the Work. Such assignments are special requirements over which the Contractor has no choice or option. They are intended to establish which party or entity involved in a specific element of the Work is considered as being sufficiently experienced in the indicated construction processes or operations to be recognized as "expert" in those processes or operations. Nevertheless, the ultimate responsibility for fulfilling all contract requirements remains with the Contractor.
 - 1. These requirements should not be interpreted to conflict with the enforcement of building codes and similar regulations governing the Work. They are also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
- F. Trades: The use of certain titles such as "carpentry" in the specification, is not intended to imply that the Work must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter". It also is not intended to imply that the requirements specified apply exclusively to tradespersons of that corresponding generic name.

1.4 DRAWING SYMBOLS

- A. General: Except as otherwise indicated, graphic symbols used on the drawings are those symbols recognized in the construction industry for purposes indicated. Where not otherwise noted, symbols are defined by "Architectural Graphic Standards", published by John Wiley & Sons, Inc., seventh edition.

1.5 INDUSTRY STANDARDS

- A. Applicability of Standards: Except where more explicit or stringent requirements are written into the contract documents, applicable construction industry standards have the same force and effect as if bound into or copied directly into the contract documents. Such industry standards are made a part of the contract documents by reference. Individual specification sections indicate which codes and standards the Contractor must keep available at the project site for reference.
 - 1. Referenced standards (standards referenced directly in the contract documents) take precedence over standards that are not referenced but generally recognized in the industry for applicability to the Work.
 - 2. Unreferenced Standards: Except as otherwise limited by the contract documents, standards not referenced but recognized in the construction industry as having direct applicability will be enforced for performance of the Work. The decision as to whether an industry code or standard is applicable, or as to which of several standards are applicable, is the sole responsibility of the Engineer.
- B. Publication Dates: Except as otherwise indicated, where compliance with an industry standard is required, comply with standard in effect as of date of contract documents.
 - 1. Updated Standards: At the request of the Engineer, Contractor or governing authority, submit a change order proposal where an applicable industry code or standard has been revised and reissued after the date of the contract documents and before the performance of the Work affected. The Engineer will decide whether to issue a change order to proceed with the updated standard.
- C. Conflicting Requirements: Where compliance with two or more standards is specified, and where these standards establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the contract documents specifically indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Engineer for a decision before proceeding.
 - 1. Minimum Quantities or Quality Levels: In every instance the quantity or quality level shown or specified is intended to be the minimum to be provided or performed. Unless otherwise indicated, the actual Work may either comply exactly, within specified tolerances, with the minimum quantity or quality specified, or may exceed that minimum within reasonable limits. In complying with these requirements, the indicated numeric values are minimum or maximum values, as noted, or as appropriate for the context of the requirements. Refer instances of uncertainty to the Engineer for decision before proceeding.
- D. Copies of Standards: The contract documents require that each entity performing work be experienced in that part of the Work being performed. Each entity is also required to be familiar with industry standards

applicable to that part of the Work. Copies of applicable standards are not bound with the contract documents.

1. Where copies of standards are needed for proper performance of the Work, the Contractor is required to obtain such copies directly from the publication source.
 2. Although copies of standards needed for enforcement of requirements may be required submittals, the Engineer reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.
- E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in contract documents are defined to mean the associated names. Both names and addresses are subject to change, and are believed to be, but are not assured to be, accurate and up-to-date as of date of contract documents:
1. ANSI - American National Standards Institute, 1430 Broadway, New York, NY 10018, (212) 354-3300
 2. ASTM - ASTM, 655 Fifteenth Street NW, Washington, DC 20005, (202) 639-4025
 3. AWS - American Welding Society, P.O. Box 351040, 550 Le Jeune Road NW, Miami, FL 33135, (305) 443-9353
- F. Federal Government Agencies: Names and titles of federal government standard or specification producing agencies are frequently abbreviated. The following acronyms or abbreviations as referenced in the contract documents indicate names of standard or specification producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up-to-date as of the date of the contract documents.
1. EPA - Environmental Protection Agency, 401 M Street SW, Washington, DC 20460, (202) 829-3535
 2. OSHA - Occupational Safety and Health Administration (U.S. Department of Labor), Government Printing Office, Washington, DC 20402, (202) 783-3238

1.6 GOVERNING REGULATIONS/AUTHORITIES

- A. General: The procedure followed has been to contact governing authorities where necessary to obtain information needed for the purpose of preparing contract documents; recognizing that such information may or may not be of significance in relation to the Contractor's responsibilities for performing the Work. Contact governing authorities directly for necessary information and decisions having a bearing on performance of the Work.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Temporary Utilities:
 - 1. Temporary electricity.
- B. Construction Facilities:
 - 1. Vehicular access, Parking, and Paved Area Use.
 - 2. Progress cleaning and waste removal.
- C. Temporary Controls:
 - 1. Barriers.
 - 2. Security.
- D. Construction Aids:
 - 1. Temporary runways, scaffolding, and ladders.
 - 2. Welding
- E. Removal of utilities, facilities, and controls.

1.2 TEMPORARY ELECTRICITY

- A. Owner will pay cost of energy used. Exercise measures to conserve energy. Utilize Owner's existing power service.
- B. Do not disrupt Owner's use of service.
- C. Complement existing power service capacity and characteristics as required for construction operations.
- D. If temporary wiring interferes with construction or the Owner's operation of the facility, it shall be relocated.
- E. Permanent convenience receptacles may be utilized during construction.
- F. When temporary service is no longer needed, remove all temporary electrical facilities from the site.

1.3 TEMPORARY SANITARY FACILITIES

- A. Contractor shall provide temporary sanitary facility for their use. Contractor will be responsible for maintenance and upkeep of these facilities for the duration of the project. Location of these facilities will be determined by owner and will be coordinated with contractor.
- B. Chemical toilets and their maintenance shall meet the requirements of State and local health regulations and ordinances. Any facilities or maintenance methods failing to meet these requirements shall be corrected immediately.
- C. At end of construction, return existing facilities used for construction operations to same or better condition as original condition.

1.4 VEHICULAR ACCESS, PARKING, AND PAVED AREA USE

- A. Use designated existing on-site roads for construction traffic.
- B. Use of designated existing on-site streets and driveways used for construction traffic and parking is permitted. Tracked vehicles not allowed on paved areas.

- C. Do not allow heavy vehicles or construction equipment in parking areas.
- D. Maintenance:
 - 1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, snow, and ice.

1.5 PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing spaces.
- C. Broom and vacuum clean interior areas prior to start of surface finishing and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and rubbish from site as needed and dispose off-site.

1.6 SECURITY

- A. Security Program:
 - 1. Protect Work from theft, vandalism, and unauthorized entry.
 - 2. Initiate program in coordination with Owner's existing security system at project mobilization.
 - 3. Maintain program throughout construction period until Owner acceptance precludes need for Contractor security.
 - 4. Contractor shall be responsible for providing background checks and/or any other initial personnel processing to perform work at KCAB.

1.7 TEMPORARY RUNWAYS, SCAFFOLDING, AND LADDERS

- A. Provide temporary ladders, ramps, and runways as required for performance and inspection of the work. The above facilities shall be constructed and maintained in accordance with the applicable Federal, State, and Municipal regulations and codes.
- B. Furnish, erect, and maintain all scaffolding required for this work. Scaffolding shall be constructed and maintained in accordance with applicable State and Federal laws and local ordinances. Scaffolding shall be promptly removed after serving its purpose.
- C. The structural strength and safety of scaffolding, runways, covers, railings, ladders, stairs, etc., and compliance with law shall be the sole responsibility of the Contractor.

1.8 WELDING

- A. Provide all welding equipment and welding provisions needed to complete work.
- B. Contractor shall provide electrician to support welding work.

1.9 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion or as soon as the Engineer deems permissible.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

- D. Surfacing and sub-base material used for temporary road and parking areas shall be removed, unless otherwise directed by the Engineer.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Products.
- B. Product delivery requirements.
- C. Product storage and handling requirements.
- D. Product options.
- E. Product substitution procedures.
- F. Equipment electrical characteristics and components.

1.2 PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.
- C. Furnish interchangeable components from same manufacturer for components being replaced.

1.3 PRODUCT DELIVERY REQUIREMENTS

- A. Manufactured materials and products shall be delivered as needed for installation.
- B. Transport and handle products in accordance with manufacturer's instructions.
- C. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged, in original packages, containers, or bundles, as packaged by the manufacturer with manufacturer's name, brand, seals, and labels intact.
- D. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.
- E. Materials other than those designated within the Specifications or approved by the Owner shall not be delivered to the project site.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store, protect, and preserve products in accordance with manufacturers' instructions. Store all materials in a manner to facilitate inspection and to prevent damage, contamination, or intermixing.
- B. Repair any damage resulting from improper storage procedures, including damage caused by condensation or the elements. If products cannot be repaired to the specified condition as determined by the Engineer, Contractor shall replace them at no additional cost.
- C. Contractor shall properly coordinate delivery of equipment/materials to limit to the maximum extent possible storage time on site.
- D. Store with seals and labels intact and legible.

- E. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- F. For exterior storage of fabricated products, place on sloped supports above ground.
- G. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- H. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- I. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- J. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description, subject to the review of product data and concurrence by the Owner as specified in Section 01 33 00.
- B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article. Substitutions are subject to concurrence by the Owner as specified in Section 01 33 00.

1.6 PRODUCT SUBSTITUTION PROCEDURES

- A. Engineer will consider requests for Substitutions only within 15 days after date of Owner-Contractor Agreement.
- B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.
- C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- D. A request constitutes a representation that Contractor:
 1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
 2. Will provide same warranty for Substitution as for specified product.
 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 5. Will reimburse Owner for review or redesign services associated with re-approval by authorities having jurisdiction.
- E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.
- F. Substitution Submittal Procedure:

1. Submit request for Substitution for consideration in accordance with the requirements of Section 01 33 00. Limit each request to one proposed Substitution.
2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
3. Engineer will notify Contractor in writing of decision to accept or reject request.

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description of requirements.
- B. Prerequisites to substantial completion.
- C. Prerequisites to final completion.
- D. Final cleaning.
- E. Starting of systems.
- F. Protecting installed construction.
- G. Project record documents.
- H. Operation and maintenance data.
- I. Manual for equipment and systems.
- J. Spare parts and maintenance products.

1.2 DESCRIPTION OF REQUIREMENTS

- A. Project closeout is the term used to describe certain collective project requirements, indicating completion of the Work that is to be fulfilled near the end of the Contract time in preparation for final acceptance and occupancy of the Work by the Owner, as well as final payment to the Contractor and the normal termination of the Contract.
- B. Specific requirements for individual units of work are included in the appropriate sections.
- C. Time of closeout is directly related to "Final Completion"; therefore, the time of closeout may be either a single time period for the entire Work or a series of time periods for individual elements of the Work that have been certified as substantially complete at different dates. This time variation, if any, shall be applicable to the other provisions of this section.

1.3 PREREQUISITES TO SUBSTANTIAL COMPLETION

- A. General: Complete the following before requesting the Engineer's inspection for certification of substantial completion, either for the entire Work or for portions of the Work. List known exceptions in the request.
 - 1. In the progress payment request that coincides with, or is the first request following, the date substantial completion is claimed, show either 100% completion for the portion of the Work claimed as "substantially complete", or list incomplete items, the value of incomplete work, and reasons for the Work being incomplete. Include supporting documentation for completion as indicated in these contract documents.
 - 2. Submit a statement showing an accounting of changes to the Contract Sum.
 - 3. Submit specific warranties, workmanship/maintenance bonds, final certifications and similar documents.

4. Obtain and submit releases enabling the Owner's full, unrestricted use of the Work.
5. Submit record drawings, maintenance manuals, damage or settlement survey, and similar final record information.
6. Discontinue and remove temporary facilities and services from the project site, along with construction tools and facilities.

- B. Inspection Procedures: Upon receipt of the Contractor's Request for Substantial Completion, the Engineer will either proceed with inspection or advise the Contractor of unfilled prerequisites.
1. Following the initial inspection, the Engineer will either prepare the certificate of substantial completion or will advise the Contractor of work which must be performed before the certificate will be issued. The Engineer will repeat the inspection when requested and when assured that the Work has been substantially completed.
 2. Results of the completed inspection will form the initial "punch-list" for final acceptance.

1.4 PREREQUISITES TO FINAL ACCEPTANCE

- A. General: After the "punch-list" items have been completed the Contractor may request the Engineer's final inspection (Request for Final Completion) for certification of final completion, and final payment as required by the General Conditions. List known exceptions, if any, in the request.
1. Submit executed Request for Final Completion with executed "punch-list".
 2. Submit the final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
 3. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
 4. Submit a certified copy of the Engineer's final punch-list of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance and has been endorsed and dated by the Engineer.
 5. Submit consent of surety.
 6. Submit a final liquidated damages settlement statement, acceptable to the Owner.
- B. Re-inspection Procedure: The Engineer will re-inspect the Work upon receipt of the Contractor's notice that the work, including punch-list items resulting from earlier inspections, has been completed, except for these items whose completion has been delayed because of circumstances that are acceptable to the Engineer.
1. Upon completion of re-inspection, the Engineer will either prepare a certificate of final completion or will advise the Contractor of work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 2. If necessary, the re-inspection procedure will be repeated.

1.5 Turnover Meeting

- A. Owner will require that the contractor schedule a HVAC "Controls Turn-Over" meeting, as a condition of acceptance for substantial completion prior to Owner Training.
- B. The general contractor, design engineer, mechanical contractor, controls contractor and Owner's representative must all attend the meeting. At this meeting, the controls contractor will be required to demonstrate that the entire HVAC system is 100% complete and functional. 100% Complete and functional is defined as demonstration that the system(s) can operate per the sequence of operations as written in the design documents.
- C. Substantial completion of the project shall not be completed until the performance testing has been acceptable by the Owner. Mechanical Contractor, Controls Contractor and Design Engineer shall revisit site as necessary to complete the performance tests until Owner accepts the substantial completion. Additional site visits by the design and contracting team shall not be considered additional services and shall not be charged to the owner.

- D. Contractor shall provide digital and hard copies of the O & M manuals and record drawings at turnover. Ensure all record drawings are scanned as individual sheets.

1.6 FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
- B. Except as otherwise indicated or requested by the Engineer, remove temporary protection devices and facilities which were installed during the course of the Work to protect previously completed Work during the remainder of the construction period.
- C. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
- D. Clean filters of operating equipment.
- E. Clean site; sweep paved areas, rake clean landscaped surfaces.
- F. Remove waste and surplus materials, rubbish, and construction facilities from site. Comply with safety standards and governing regulations for cleaning operations. Do not burn waste materials at the site. Do not bury debris or excess materials on the Owner's property. Remove waste materials from the site and dispose of in a lawful manner.

1.7 STARTING OF SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems with Manufacture's Representative.
- B. Notify Engineer seven days prior to start-up of each item.
- C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of applicable manufacturer's representative and Contractors' personnel in accordance with manufacturers' instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report in accordance with Section 01 33 00 - Submittal Procedures that equipment or system has been properly installed and is functioning correctly.

1.8 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic from landscaped areas.

1.9 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction. Protect from deterioration and loss in a secure, fire-resistive location.
- D. Provide access to record documents for Owner and Engineer reference during normal working hours.
- E. Record information concurrent with construction progress, not less than weekly. All record documents must be kept up to date on a continuous basis by all contractors and subcontractors. Failure to do so will result in withholding additional money from monthly payment requests.
- F. Record Specifications:
 - 1. Maintain one complete copy of the Project Manual, including specifications and addenda, and one copy of other written construction documents such as change orders and similar modifications issued in printed form during construction.
 - 2. Legibly mark and record at each product section description of actual products installed, including the following:
 - a. Manufacturer's name and product model and number.
 - b. Product substitutions or alternates utilized.
 - c. Changes made by Addenda and modifications.
- G. Record Drawings and Shop Drawings:
 - 1. Legibly mark each item to record actual construction including:
 - a. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - b. Field changes of dimension and detail.
 - c. Details not on original Contract drawings.
 - 2. Mark whichever drawing is most capable of showing the actual "field" condition fully and accurately; however, where shop drawings are used for mark-up, record a cross-reference at the corresponding location on the working drawings.
 - a. Mark record sets with red erasable pencil and, where feasible, use other colors to distinguish between variations in separate categories of work.
 - b. Mark-up new information which is known to be important to the Owner and Engineer but was not shown on either contract drawings or shop drawings.
 - c. Note related change-order numbers where applicable.
 - d. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.

- H. Record Product Data: Maintain one copy of each product data submittal. Mark these documents to show significant variations in the actual Work performed in comparison with the submitted information. Include both variations in the products as delivered to the site, and variations from the manufacturer's instructions and recommendations for installation. Give particular attention to concealed products and portions of the Work which cannot otherwise be readily discerned at a later date by direct observation. Note related change orders and mark-up of record drawings and specifications.
 - 1. Upon Completion of mark-up, submit complete set of record product data to the Engineer for the Owner's records.
- I. Miscellaneous Record Submittals: Refer to other sections of these specifications for requirements of miscellaneous record-keeping and submittals in connection with the actual performance of the Work. Immediately prior to the date or dates of substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the Engineer for the Owner's records.
- J. Submit documents to Engineer with claim for final Application for Payment.

1.10 OPERATION AND MAINTENANCE DATA

- A. Submit data bound in 8-1/2 x 11-inch text pages, three D side ring binders with durable covers and digital copies of all manuals at closeout.
- B. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter of binder when multiple binders are required.
- C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- E. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - f. Maintenance instructions for [special] finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 - 3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Certificates.
 - c. Originals of warranties and bonds.

1.11 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

- B. Submit one copy of completed volume 15 days prior to final inspection. Draft copy be reviewed and returned, with Engineer comments. Revise content of document sets as required prior to final submission.
- C. Submit two sets of revised final volumes in final form within 10 days after final inspection.
- D. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
- E. Include manufacturer's printed operation and maintenance instructions.
- F. Additional Requirements: As specified in individual product specification sections.
- G. Include listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

1.12 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver to Project site and place in location as directed by Owner; obtain receipt prior to final payment.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 024119

SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preparation.
- B. Examination.
- C. Equipment Removal.
- D. Salvage Requirements.
- E. Demolition.

1.2 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of capped utilities, concealed utilities discovered during demolition, and subsurface obstructions.

1.3 QUALITY ASSURANCE

- A. Conform to applicable code for demolition work, dust control, products requiring electrical disconnection and re-connection.
- B. Conform to applicable code for procedures when hazardous or contaminated materials are discovered.
- C. Obtain required permits from authorities having jurisdiction.

1.4 SCHEDULING

- A. Cooperate with Owner in scheduling noisy operations and waste removal that may impact Owners operation and adjoining spaces.
- B. Coordinate with the Owner any building service interruptions.
 - 1. Do not disable or disrupt building fire or life safety systems without three calendar days prior written notice to Owner.
 - 2. Schedule tie-ins to existing systems to minimize disruption.
 - 3. Coordinate Work to ensure fire alarms, smoke detectors, emergency lighting, exit signs and other life safety systems remain in full operation in occupied areas.

1.5 PROJECT CONDITIONS

- A. Conduct demolition to minimize interference with adjacent building areas.
- B. Cease operations immediately if structure appears to be in danger and notify Engineer. Do not resume operations until directed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 PREPARATION

- A. Mark location and termination of utilities.
- B. Erect, and maintain temporary barriers and security devices at locations indicated, including warning signs and lights, and similar measures, for protection of the Owner and existing improvements indicated to remain.
- C. Erect and maintain temporary partitions to prevent spread of dust, odors, and noise to permit continued Owner occupancy, where necessary.
- D. Prevent movement of structure; provide temporary bracing and shoring as required to ensure safety of existing structure.
- E. Provide appropriate temporary signage including signage for exit or building egress.
- F. Do not close or obstruct building egress path.

3.2 EXAMINATION

- A. Examine existing equipment and structures indicated to be demolished before demolition.
- B. Determine where removals may result in structural deficiency or unplanned building collapse during demolition. Coordinate demolition sequence and procedures to prevent structures from becoming unstable.
- C. Determine where demolition may affect structural integrity or weather resistance of adjacent buildings or structures indicated to remain.
 - 1. Identify measures required to protect adjacent buildings and structures from damage.
 - 2. Identify remedial work including patching, repairing, bracing, and other work required to leave buildings and structures indicated to remain in structurally sound and weathertight and watertight condition.

3.3 EQUIPMENT REMOVAL

- A. Piping, fittings, equipment, and accessories to be replaced as shown on the Contract Drawings shall be removed by the Contractor.
- B. The piping, fittings, equipment, and accessories shall be removed from the site by the Contractor at his own expense. The equipment shall be removed from the site within seven (7) days of removing it from the building.

3.4 SALVAGE REQUIREMENTS

- A. Coordinate with Owner/Engineer to identify equipment required to be removed and delivered to Owner.
- B. Tag components and equipment Owner designates for salvage. Identification tags shall remain intact on all removed equipment and identify the date and location from which the salvaged item was removed.
- C. Protect designated salvage items from demolition operations until items can be removed.
- D. Remove materials to be re-installed or retained in manner to prevent damage. Store and protect in accordance with requirements of Section 01 60 00.

- E. Carefully remove building components and equipment indicated to be salvaged.
- F. Package small and loose parts to avoid loss.
- G. Mark equipment and packaged parts to permit identification and consolidation of components of each salvaged item.
- H. Prepare assembly instructions consistent with disassembled parts. Package assembly instructions in protective envelope and securely attach to each salvaged item.

3.5 DEMOLITION

- A. Contractor is not allowed to bring a dumpster to the site. At the end of working day, all removed items shall be hauled away and disposed of at the contractor expense.
- B. Maintain protected egress from and access to adjacent existing buildings at all times.
- C. Do not close or obstruct roadways or sidewalks without Owner approval.
- D. Cease operations immediately if structure appears to be in danger and notify Engineer.
- E. Disconnect and remove designated utilities within demolition areas.
- F. Cap and identify abandoned utilities at termination points when utility is not completely removed. Annotate Record Drawings indicating location and type of service for capped utilities remaining after demolition.
- G. Demolish in orderly and careful manner. Protect existing improvements and supporting structural members.
- H. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
- I. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.
- J. The owner may choose to allow storage of removed materials in mechanical room if space is available.
- K. Conduct demolition to minimize interference with adjacent building areas.
- L. Project site does not allow contractor to bring a dumpster onsite.
- M. At the end of working day, contractor must haul away and dispose all removed materials at the contractor expense. The owner may choose to allow storage of removed materials in mechanical room if space is available.

END OF SECTION

SECTION 05 05 05

METAL MATERIALS, METHODS AND FASTENING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The basic materials and methods required for the work of Division 5, Metals.

PART 2 PRODUCTS

2.1 STEEL

- A. Steel shall comply with ASTM A36, or ASTM A572 Gr 50 as indicated on the drawings.

2.2 BOLTS

- A. High strength bolts shall comply with ASTM A325.
- B. Anchor bolts and connection bolts for steel assemblies and steel to concrete connections shall comply with ASTM A307 or ASTM A36.

2.3 WELDING ELECTRODES

- A. Filler metal for welding shall comply with AWS D1.1, Structural Welding Code.

2.4 FABRICATION

- A. Fabricate all metal parts to comply with the design indicated on the Drawings. Make field measurements and prepare templates as required to ensure proper fit. Assemblies shall be fitted together in the shop and delivered to the site complete and ready for installation.
- B. Form metal shapes with sharp lines and angles, and finish with smooth surfaces. Shearings and punchings shall be clean and true. In general, holes for bolts shall be drilled or reamed 1/16 inch larger than the diameter of the bolt. Holes for anchor bolts shall be 1 1/3 times the anchor bolt diameter.
- C. Metal thicknesses, assembly details, and supports shall provide ample strength and stiffness. Joints shall be designed to prevent trapping of moisture.
- D. Fasteners and Connections: Provide fastening devices as required and in compliance with the Drawings and shop drawings. Provide welded shop connections or concealed fastenings wherever practicable.
- E. Structural joints made using high strength bolts, hardened washers, and nuts tightened to a high bolt tension shall comply with the "Specification for Structural Joints Using ASTM A325 or A490 Bolts", issued by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.

- F. Welded joints shall comply with AWS D1.1, "Structural Welding Code", and AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings". All welds shall be made by operators who have been previously qualified as prescribed by AWS B3.0, Welding Procedure and Performance Qualification. All welds exposed to view shall be dressed smooth.

2.5 TEMPLATES, LEVELING PLATES, AND APPURTENANCES

- A. Provide all templates, leveling plates, and appurtenances required for the installation of metal work.

PART 3 EXECUTION

3.1 ERECTION

- A. Erect structural steel in compliance with the AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" and the AISC "Code of Standard Practice".
- B. Prior to assembling members, clean bearing surfaces and surfaces to be in permanent contact to remove dirt and scale.
- C. Set members accurately to the lines and levels indicated on the Drawings and shop details. Unless otherwise indicated, individual pieces shall be erected so that the deviation from plumb, level, and alignment shall not exceed 1 to 500.
- D. Field correction of fabrication errors by use of gas cutting torches shall be allowed only if approved by the Engineer for each specific condition.
- E. After erection, touch up all burned and abraded areas where the painted surfaces or existing painted surfaces have been damaged. Clean and prepare areas according to SSPC-SP3 "Power Tool Cleaning" prior to application of paint. Paint system shall be the same as used to paint the interior surfaces of the existing steel surfaces. Contact Coating Contractor or Engineer for paint system to be used.

END OF SECTION

SECTION 09 05 11

ACOUSTICAL PANEL CEILING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes replacement of acoustical ceiling panels and exposed suspension system, as necessitated by removal of existing ceilings and installation of new HVAC and electrical.

1.02 SUBMITTALS

- A. Product Data: For each type of product specified.
- B. Product Test Reports: Indicate compliance of acoustical panel ceilings and components with requirements based on comprehensive testing of current products.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who has completed acoustical panel ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Source Limitations for Ceiling Units: Obtain each acoustical ceiling panel from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
- C. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
 - 1. Surface-burning characteristics of acoustical panels comply with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84.
 - 2. Fire-resistance-rated assemblies, which are indicated by design designations from UL's "Fire Resistance Directory," from ITS/Warnock Hersey's "Directory of Listed Products," or from the listings of another testing and inspecting agency, are identical in materials and construction to those tested per ASTM E 119.
 - 3. Products are identified with appropriate markings of applicable testing and inspecting agency.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels to Project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.06 COORDINATION

- A. Coordinate installation of acoustical panels and any necessary suspension system with other construction that adjoins or penetrates ceiling.

1.07 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Full-size units equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS

2.01 ACOUSTICAL PANELS, GENERAL

- A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
- B. Acoustical Panel Colors and Patterns: Match existing acoustic panels (Contractor shall confirm), ensure panels in secured areas are detention grade.

2.02 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension system together with any edge suspension or support hardware and components to match existing suspension system.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
- C. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, Direct Hung) will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.
- E. Sheet-Metal Edge Moldings and Trim: Manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners.
 - 1. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's Retain one finish requirement above or below, or delete and insert others.
 - 2. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Comply with paint manufacturer's written instructions for applying and baking and for minimum dry film thickness.
 - a. Organic Coating: Manufacturer's standard thermosetting coating system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).
 - b. Color: White.
 - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong World Industries, Inc.
 - b. Chicago Metallic Corporation.
 - c. USG Interiors, Inc.
- F. Hold-Down Clips for Non-Fire-Resistance-Rated Ceilings: For interior ceilings consisting of acoustical panels weighing less than 1 lb/sq. ft. (4.88 kg/sq. m), provide hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage, and other conditions affecting performance of acoustical panel ceilings.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Measure each ceiling area and establish sizes and layout of new or replacement acoustical panels. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.03 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with publications referenced below per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - 1. Standard for Ceiling Suspension System Installations: Comply with ASTM C 636.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - 3. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure; that are appropriate for substrate; and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 4. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; and provide hangers not more than 8 inches (200 mm) from ends of each member.
- C. Install edge moldings, hangers and trim at required electrical panel soffit at Gymnasium entry in coordination with surface mounted electrical junction box and access panel at ceiling. Set soffit below panel and provide minimum of 6 inches clear at sides of electrical box. Coordinate installation of soffit with new gypsum drywall installation over existing metal louvers above adjacent doorway and Coordinate height of bottom of soffit to provide sufficient clearance to permit removal of acoustic panel at bottom face of soffit without damage to panel. Butt trim at wall and new transom and provide moldings at all corners of soffit.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m). Miter corners accurately and connect securely.
 - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels in alternating pattern:
 - a. To match existing pattern.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
3. Paint cut panel edges remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
4. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.04 CLEANING

1. Clean exposed surfaces of acoustical panel ceilings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
2. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 09 09 12

PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.
- B. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- C. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
- D. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.
- E. Painting included in this Section includes the following:
 - a. New or existing CMU block wall, gypsum wallboard in areas where any patching has occurred, interior or exterior of the building.
 - b. New exposed HVAC ductwork and fittings
- F. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1.2 DEFINITIONS

- A. Standard terms used by the coatings industry are defined in ASTM D 16.
- B. General: Standard coating terms defined in ASTM D 16 apply to this Section.
- C. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
- D. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
- E. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
- F. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.3 SUBMITTALS

- A. Product Data: For each paint system indicated. Include block fillers and primers.

- B. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
- C. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
- D. Samples for Initial Selection: For each type of finish-coat material indicated.
- E. After color selection, Architect will furnish color chips for surfaces to be coated.
- F. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
- G. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
- H. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
- I. Division 1 Section "Submittal Procedures" specifies submission of three Samples as the default requirement. Insert number below only if it differs from the number retained or inserted in the Division 1 Section.
Submit Samples on the following substrates for Architect's review of color and texture only:
 - a. Ferrous Metal: 3-inch- square Samples of flat metal of solid metal for each color and finish.
- J. Coordinate below with qualification requirements retained in "Quality Assurance" Article.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.
- C. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.6 PROJECT CONDITIONS

- A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.
- B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.
- C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- D. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.7 EXTRA MATERIALS

- A. Extra materials may not be allowed for publicly funded projects.
- B. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
- C. Quantity: Furnish Owner with an additional 5 percent, but not less than 2 gallons, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - a. Benjamin Moore & Co. (Benjamin Moore).
 - b. PPG Industries, Inc. (Pittsburgh Paints).
 - c. Sherwin-Williams Co. (Sherwin-Williams).
 - d. Pratt & Lambert (P &L)

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- C. Colors: As selected by owner from manufacturer's full range or as provided or necessary to match existing colors.

2.3 INTERIOR PRIMERS

- A. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application on new gypsum door panels or other surfaces

- a. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
 - b. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
 - c. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
- B. Interior Ferrous-Metal Primer: Factory-formulated quick-drying rust-inhibitive alkyd-based metal primer for existing hollow-metal frames.
- a. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils.
 - b. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 1.5 mils.
 - c. Sherwin-Williams; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils.
- C Interior Galvanized Metal Primer: Factory-formulated galvanized metal primer for exterior application, as required, for galvanized steel posts.
- a. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).
 - b. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils (0.076 mm).
 - c. Sherwin-Williams; Galvite HS Paint B50WZ3: Applied at a dry film thickness of not less than 2.0 mils (0.051 mm).

2.4 INTERIOR FINISH COATS

- A. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel for gypsum drywall panels in corridors and other public areas.
- a. Benjamin Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils.
 - b. Pittsburgh Paints; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils.
 - c. Sherwin-Williams; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
- B. Interior Full-Gloss Alkyd Enamel for Metal Surfaces: Factory-formulated full-gloss alkyd interior enamel for exposed hollow metal doors or frames and exposed HVAC ductwork.
- a. Benjamin Moore; Moore's IMC Urethane Alkyd Enamel No. M22: Applied at a dry film thickness of not less than 2.0 mils.
 - b. Pittsburgh Paints; 7-814 Series Pittsburgh Paints Industrial Gloss-Oil Interior/Exterior Enamel: Applied at a dry film thickness of not less than 1.5 mils.
 - c. Sherwin-Williams; ProMar 200 Alkyd Gloss Enamel B35W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.
- B. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

- C. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.
- D. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
- E. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
- B. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- C. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
- D. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- E. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
- F. Provide barrier coats over incompatible primers or remove and reprime.
- G. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
 - a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.
- H. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- I. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
- J. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
- K. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
- L. Use only thinners approved by paint manufacturer and only within recommended limits.

- M. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
- B. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
- C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
- D. Provide finish coats that are compatible with primers used.
- E. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convactor covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
- F. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
- G. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
- H. Sand lightly between each succeeding enamel or varnish coat.
- I. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
- J. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
- K. Omit primer over metal surfaces that have been shop primed and touchup painted.
- L. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
- M. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- N. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
- O. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.

- P. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
- Q. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- R. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- S. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- T. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- U. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.
- B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.5 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.
- B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.
- C. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 INTERIOR PAINT SCHEDULE

- A. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:
 - Low-Luster Acrylic-Enamel Finish Two finish coats over a primer for all new surfaces.
 - a. Primer: Interior gypsum board primer.
 - b. Finish Coats: Interior low-luster acrylic enamel.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes single and three-phase motors for application on equipment provided under other sections.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- B. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and protect products on site.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

- A. Motors 3/4 hp and Larger: Three-phase motor as specified below.
- B. All motors with VFDs shall be provided with Shaft/bearing grounding rings.
- C. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.
- D. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: 1.15
 - 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
 - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 5. Insulation System: NEMA Class F
 - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 - 7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 - 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 - 9. Sound Power Levels: Conform to NEMA MG 1.
 - 10.
- E. Single Phase Motors:
 - 1. Permanent split-capacitor type where available, otherwise uses split-phase start/capacitor run or capacitor start/capacitor run motor.
 - 2. Voltage: As indicated on drawings, single phase, 60 Hz.
- F. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- B. Install engraved plastic nameplates in accordance with Section 26 05 53.
- C. Ground and bond motors in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe hangers and supports.
 - 2. Hanger rods.
 - 3. Inserts.
 - 4. Flashing.
 - 5. Sleeves.
 - 6. Mechanical sleeve seals.
 - 7. Formed steel channel.
 - 8. Firestopping relating to HVAC work.
 - 9. Firestopping accessories.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.1 - Power Piping.
 - 2. ASME B31.5 - Refrigeration Piping.
 - 3. ASME B31.9 - Building Services Piping.
- B. ASTM International:
 - 1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 2. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
 - 3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- C. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- D. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- E. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction. All existing corridor walls are treated as fire rated walls.

1.4 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
- B. B. Surface Burning: ASTM E84, UL 723 with maximum flame spread / smoke developed rating of 25/450.
- C. Firestop interruptions to fire rated assemblies, materials, and components. Fire rating of existing walls is shown on Drawing Sheet A-001.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.6 SUBMITTALS

- A. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
- B. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- D. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor [and Roof] Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- C. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 1. Carpenter & Paterson Inc.
 2. Creative Systems Inc.
 3. Flex-Weld, Inc.
 4. Glope Pipe Hanger Products Inc.
 5. Michigan Hanger Co.
 6. Superior Valve Co.
- B. Hydronic Piping:
 1. Conform to ASME B31.9
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
 5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 6. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
 7. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
 8. Vertical Support: Steel riser clamp.
 9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 10. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

11. Copper Pipe Support: Copper-plated, carbon steel ring.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

E. Sealant: Acrylic.

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline Link-Seal, Inc.
2. NMP Corporation.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:

1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division
4. Unistrut Corp.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.8 FIRESTOPPING

A. Manufacturers:

1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M fire Protection Products
6. Specified Technology, Inc.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

1. Foam Firestopping Compounds: Multiple component foam compound.
2. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
3. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.

C. Color: To be selected by architect/engineer.

2.9 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:

1. Sheet metal.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:

1. Furnish UL listed products [or products tested by independent testing laboratory.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing or damming materials to arrest liquid material leakage.
- D. Obtain permission from Owner before using powder-actuated anchors.
- E. Obtain permission from Owner before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1; ASME B31.5; ASME 31.9; ASTM F708.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every other floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.

- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation.

3.5 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- C. Provide curbs for roof installations 12 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.
- D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install chrome plated steel stainless steel escutcheons at finished surfaces.

3.7 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.

- E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
- F. Place intumescent coating in sufficient coats to achieve rating required.
- G. Remove dam material after firestopping material has cured.
- H. Fire Rated Surface:
 - 1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - 2. Where cable tray, bus, cable bus, conduit, wireway, trough, and penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- I. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 - 2. Install escutcheons, floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - 3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
 - 4. Interior partitions: Seal pipe penetrations at computer rooms, telecommunication rooms and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.8 FIELD QUALITY CONTROL

- A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.9 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.10 PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

3.11 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 1)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8

B. Plastic and Ductile Iron Pipe Hanger Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
PVC (All Sizes)	4	3/8

- C. Note 1: 20 feet maximum spacing, minimum of one hanger for each pipe section close to joint behind bell. Provide hanger at each change of direction and each branch connection. For pipe sizes 6 inches and smaller, subjected to loadings other than weight of pipe and contents, limit span to maximum spacing for water service steel pipe.

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Tags.
 - 3. Stencils.
 - 4. Pipe markers.
 - 5. Duct markers.
 - 6. Labels.
 - 7. Lockout devices.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturers catalog literature for each product required.
- B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Safety Sign Co.
 - 3. Seton Identification Products

- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Safety Sign Co.
 - 3. Seton Identification Products
- B. Plastic Tags
 - 1. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
- C. Metal Tags:
 - 1. Aluminum with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- D. Information Tags:
 - 1. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- E. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 PIPE MARKERS

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Safety Sign Co.
 - 3. Seton Identification Products
- B. Color and Lettering: Conform to ASME A13.1.
- C. Plastic Pipe Markers:
 - 1. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
 - 2. Bright colored continuously printed plastic sheet with separate direction allows. 1-1/4" size letters for pipe size 2" and smaller. 2-1/2" for pipe sizes 2-1/2" and larger.
- D. Plastic Underground Pipe Markers:
 - 1. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.4 DUCT MARKERS

- A. Manufacturers:
 - 1. Brimar
 - 2. Craftmark Identification Systems
 - 3. Safety Sign Co.
 - 4. Seton Identification Products
- B. Color and Lettering: Conform to ASME A13.1.
- C. Vinyl Markers:

1. Self-adhesive duct markers with directional arrow made with a minimum 3 mil thick high gloss vinyl film printed using UV and chemical resistant inks.
2. For ducts 24" and smaller provide a minimum 14" x 2-1/4" marker with 1-1/2" characters.
3. For ducts 26" and larger provide a minimum 24" x 4" marker with 2-1/2" characters.

2.5 LABELS

- A. Manufacturers:
 1. Craftmark Identification Systems
 2. Safety Sign Co.
 3. Seton Identification Products
- B. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification.

2.6 LOCKOUT DEVICES

- A. Lockout Hasps:
- B. Manufacturers:
 1. Craftmark Identification Systems
 2. Safety Sign Co.
 3. Seton Identification Products
- C. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.
- D. Valve Lockout Devices:
 1. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install identifying devices after completion of coverings and painting.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- D. Install tags using corrosion resistant chain. Number tags consecutively by location.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
- G. Identify control panels and major control components outside panels with plastic nameplates.

- H. Identify valves in main and branch piping with tags.
- I. Install duct markers when duct surface is dry and reasonably clean.
- J. Install duct markers when surface temperature is above 50° F.
- K. Identify air terminal units and radiator valves with numbered tags.
- L. Tag automatic controls, instruments, and relays. Key to control schematic.
- M. Identify piping, concealed or exposed, with plastic pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- N. For exposed natural gas lines other than steel pipe, attach yellow pipe labels with "GAS" in black lettering, at maximum 5 foot o.c. spacing.
- O. Identify ductwork with duct markers. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- P. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 WORK INCLUDES

- A. Contractor provide:
 - 1. Testing adjusting and balancing of hydronic and refrigeration systems.
 - 2. Measurement of final operating condition of HVAC systems.
 - 3. Sound measurement of equipment operating conditions.
 - 4. Vibration measurement of equipment operating conditions.

1.2 REFERENCES

- A. Associated Air Balance Council:
 - 1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
- C. Natural Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

- A. Prior to commencing Work, submit proof of latest calibration date of each instrument.
- B. Test Reports: Indicate data on forms prepared following ASHRAE 111
- C. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- D. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or Copy of NEBB Certificate of Conformance Certification.
- E. Submit draft copies of report for review prior to final acceptance of Project.
- F. Furnish reports in soft cover, letter size, binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 77 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

- C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ASHRAE 111.
- B. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC or Certified by NEBB.
- B. Perform Work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, or registered professional engineer experienced in performance of this Work and licensed in State of Illinois.

1.7 SEQUENCING

- A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify systems are complete and operable before commencing work. Verify the following:
 1. Systems are started and operating in safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place or in normal position.
 15. Service and balancing valves are open.

3.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.

- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

- A. Verify recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- D. Report defects and deficiencies noted during performance of services, preventing system balance.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

- K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.
- M. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

3.6 WATER SYSTEM PROCEDURE

- A. Adjust water systems, after air balancing, to obtain design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.
- C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Air Cooled Condensers.
 - 2. Unit Air Conditioners.
 - 3. Air Coils.
 - 4. Terminal Heat Transfer Units.
 - 5. Roof Top Units.
 - 6. Fans.
 - 7. Air Filters.
 - 8. Air Terminal Units.
 - 9. Air Inlets and Outlets.
 - 10. Existing Grilles/Registers and Dampers.
 - 11. Boilers.
- B. Report Forms
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name

- e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
 5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
 6. Air Cooled Condenser:
 - a. Identification/number
 - b. Location
 - c. Manufacturer
 - d. Model number
 - e. Serial number
 - f. Entering DB air temperature, design and actual
 - g. Leaving DB air temperature, design and actual
 - h. Number of compressors
 7. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual

- i. Leaving air WB temperature, design and actual
 - j. Water flow, design and actual
 - k. Water pressure drop, design and actual
 - l. Entering water temperature, design and actual
 - m. Leaving water temperature, design and actual
 - n. Saturated suction temperature, design and actual
 - o. Air pressure drop, design and actual
8. Heating Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual
9. Air Moving Equipment:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
10. Return Air/Outside Air Data:
- a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
11. Exhaust Fan Data:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number

- e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
12. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
13. Duct Leak Test:
- a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
14. Air Monitoring Station Data:
- a. Identification/location
 - b. System
 - c. Size
 - d. Area
 - e. Design velocity
 - f. Design air flow
 - g. Test velocity
 - h. Test air flow
15. Terminal Unit Data:
- a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure
16. Air Distribution Test Sheet:

- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow
17. Sound Level Report:
- a. Location
 - b. Octave bands - equipment off
 - c. Octave bands - equipment on
 - d. RC level - equipment on
18. Combustion Test:
- a. Manufacturer
 - b. Model number
 - c. Serial number
 - d. Firing rate
 - e. Overfire draft
 - f. Gas meter timing dial size
 - g. Gas meter time per revolution
 - h. Gas pressure at meter outlet
 - i. Gas flow rate
 - j. Heat input
 - k. Burner manifold gas pressure
 - l. Percent carbon monoxide (CO)
 - m. Percent carbon dioxide (CO₂)
 - n. Percent oxygen (O₂)
 - o. Percent excess air
 - p. Flue gas temperature at outlet
 - q. Ambient temperature
 - r. Net stack temperature
 - s. Percent stack loss
 - t. Percent combustion efficiency
 - u. Heat output
19. Vibration Test:
- a. Location of points:
 - 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end
 - 3) Motor bearing, center (when applicable)
 - 4) Motor bearing, drive end
 - 5) Motor bearing, opposite end
 - 6) Casing (bottom or top)
 - 7) Casing (side)
 - 8) Duct after flexible connection (discharge)
 - 9) Duct after flexible connection (suction)
 - b. Test readings:
 - 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement
 - c. Normally acceptable readings, velocity and acceleration
 - d. Unusual conditions at time of test

e. Vibration source (when non-complying)

END OF SECTION

SECTION 230700

HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. HVAC piping insulation, jackets and accessories.
 2. HVAC ductwork insulation, jackets, and accessories.

1.2 REFERENCES

- A. ASTM International:
1. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
 2. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 3. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
 4. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 5. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 6. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
 7. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 8. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
 9. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
- B. Sheet Metal and Air Conditioning Contractors':
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

- A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

1.4 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

- D. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- B. Maintain temperature before, during, and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
 - 1. CertainTeed.
 - 2. Knauf.
 - 3. Johns Manville.
 - 4. Owens-Corning.
- B. Manufacturers for Closed Cell Elastomeric Insulation Products:
 - 1. Aeroflex. Aerocell.
 - 2. Armacell, LLC. Armaflex.
 - 3. Nomaco. K-flex.

2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
 - 1. Thermal Conductivity: 0.23 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 850 degrees F.
 - 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- B. TYPE P-2: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. Conform to ASTM C795 for application on Austenitic stainless steel.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 650 degrees F.
 - 3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
 - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- C. TYPE P-5: ASTM C534; Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

- A. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
 2. Thickness: 30 mil.
 3. Connections: Brush on welding adhesive.
- B. Aluminum Pipe Jacket:
1. ASTM B209.
 2. Thickness: 0.016 inch thick sheet.
 3. Finish: Smooth.
 4. Joining: Longitudinal slip joints and 2 inch laps.
 5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.4 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.
- E. Adhesives: Compatible with insulation.

2.5 DUCTWORK INSULATION

- A. TYPE D-1: ASTM C1290, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.27 at 75 degrees F.
 2. Maximum Operating Temperature: 250 degrees F.
 3. Density: 0.75 pound per cubic foot.
- B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied reinforced aluminum foil facing meeting ASTM C1136, Type II.
1. Thermal Conductivity: 0.23 at 75 degrees F.
 2. Density: 3.0 pound per cubic foot.

2.6 DUCTWORK INSULATION JACKETS

- A. Aluminum Duct Jacket:
1. ASTM B209.
 2. Thickness: 0.016 inch thick sheet.
 3. Finish: Smooth.
 4. Joining: Longitudinal slip joints and 2 inch laps.

5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

B. Aluminum Duct Jacket Systems:

1. Self-adhesive material with aluminum finish surface, color to be selected by owner.
2. Tear strength of 8.5 lbs or greater meeting ASTM D624.
3. Thickness: 6 mils sheet.
4. Finish: Smooth.
5. Non permeable with vapor barrier.
6. Mold resistant.

2.7 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, self-adhesive pad head.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Piping Systems Conveying Fluids Below Ambient Temperature:
 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- C. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.
- D. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.
- E. Insulation Terminating Points:
1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
 2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
 3. Condensate Piping: Insulate entire piping system and components to prevent condensation.
- F. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 8 feet above finished floor): Finish with PVC jacket and fitting covers.
- G. Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.
- H. Prepare pipe insulation for finish painting.

3.3 INSTALLATION - DUCTWORK SYSTEMS

- A. Duct dimensions indicated on Drawings are finished inside dimensions.
- B. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with vapor retarder jackets.
 2. Finish with tape and vapor retarder jacket.
 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.

2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces below 8 feet above finished floor: Finish with aluminum jacket.
- E. External Glass Fiber Duct Insulation:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
 2. Secure insulation without vapor retarder with staples, tape, or wires.
 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 6. Insulate and seal exhaust and relief ductwork including the exterior building air outlet and all duct back to and including the damper.
- F. Prepare duct insulation for finish painting.

3.4 SCHEDULES

A. Heating Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Heating Water Supply and Return	P-1 or P-2	1-1/2 inches and smaller	1.5
		2 inches and larger	2.0
Refrigerant Piping	P-5	1-1/2 inches and smaller	1.5
		2 inches and larger	2.0

B. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Outside Air Intake	D-2	2.0
Supply Ducts (externally insulated – Concealed above ceiling)	D-1	2.0
Return Ducts (externally insulated – Concealed above ceiling)	D-1	2.0
Supply Ducts (Mechanical Room, exposed and where noted)	D-2	2.0
Return Ducts (Mechanical Room, exposed and where noted)	D-2	2.0

Exhaust or Relief Ducts Within 10 feet of Exterior Openings and between exterior outlet and damper Thickness indicated is installed thickness.	D-2	2.0
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END OF SECTION

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes HVAC commissioning responsibilities described herein.

1.2 REFERENCES

- A. Associated Air Balance Council:
 - 1. AABC - AABC Commissioning Guideline.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE Guideline 1 - The HVAC Commissioning Process.
- C. National Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Building Systems Commissioning.

1.3 COMMISSIONING DESCRIPTION

- A. HVAC commissioning process includes the following tasks:
 - 1. Testing and startup of HVAC equipment and systems.
 - 2. Equipment and system verification checks.
 - 3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
 - 4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
 - 5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
 - 6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
 - 7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
 - 8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
 - 9. Provide training for systems specified in this Section with coordination by Commissioning Authority.
- B. Equipment and Systems to Be Commissioned:
 - 1. Piping systems.
 - 2. Ductwork.
 - 3. Variable frequency drives.
 - 4. Rooftop units.
 - 5. Heat exchangers.
 - 6. Variable Air Volume Boxes.
 - 7. Split Systems.
 - 8. Fans.

9. Fire dampers.
10. Automatic temperature control system.
11. Testing, Adjusting and Balancing work.

1.4 COMMISSIONING SUBMITTALS

- A. Draft Forms: Submit draft of system verification form and functional performance test checklist.
- B. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified.
- C. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.
- B. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASHRAE Guideline 1.

1.7 COMMISSIONING RESPONSIBILITIES

- A. Equipment or System Installer Commissioning Responsibilities:
 1. Attend commissioning meetings.
 2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
 3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
 4. Provide instructions and demonstrations for Owner's personnel.
 5. Ensure subcontractors perform assigned commissioning responsibilities.
 6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
 7. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be commissioned.
 8. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be commissioned.
 9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
 10. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
 11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
 12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
 13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.

14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
15. Provide factory supervised startup services for equipment and systems as specified. Coordinate work with manufacturer and Commissioning Authority.
16. Perform verification checks and startup on equipment and systems as specified.
17. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
18. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
19. Conduct HVAC system orientation and inspection.

B. Temperature Controls Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Review design for ability of systems to be controlled including the following:
 - a. Confirm proper hardware requirements exists to perform functional performance testing.
 - b. Confirm proper safeties and interlocks are included in design.
 - c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
 - d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
 - e. Confirm sensors selected are within device ranges.
 - f. Review sequences of operation and obtain clarification from Architect/Engineer.
 - g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
 - h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.
3. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
4. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and Architect/Engineer.
5. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
6. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan and requirements of Sections 23 09 00, 23 09 23, and 23 09 53.
7. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
8. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
9. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
10. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

C. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of 10 percent of measurements contained in testing, adjusting, and balancing report as selected by Commissioning Authority.
3. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.8 COMMISSIONING MEETINGS

- A. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.9 SCHEDULING

- A. Prepare schedule indicating anticipated start dates for the following:
 - 1. Piping system pressure testing.
 - 2. Piping system flushing and cleaning.
 - 3. Ductwork cleaning.
 - 4. Ductwork pressure testing.
 - 5. Equipment and system startups.
 - 6. Automatic temperature control system checkout.
 - 7. Testing, adjusting, and balancing.
 - 8. HVAC system orientation and inspections.
 - 9. Operation and maintenance manual submittals.
 - 10. Training sessions.
- B. Schedule seasonal tests of equipment and systems during peak weather conditions to observe full-load performance.
- C. Schedule occupancy sensitive tests of equipment and systems during conditions of both minimum and maximum occupancy or use.

1.10 COORDINATION

- A. Notify Commissioning Authority minimum of four weeks in advance of the following:
 - 1. Scheduled equipment and system startups.
 - 2. Scheduled automatic temperature control system checkout.
 - 3. Scheduled start of testing, adjusting, and balancing work.
- B. Coordinate programming of automatic temperature control system with construction and commissioning schedules.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required by Commissioning Authority.
- B. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.
- C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.

- D. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements. Refer to Section 23 33 00.
- E. Prior to start of functional performance test, install replacement filters in equipment as specified in individual section.

3.2 COMMISSIONING

- A. Seasonal Sensitive Functional Performance Tests:
 - 1. Test heating equipment at winter design temperatures.
 - 2. Test cooling equipment at summer design temperatures.
 - 3. Participate in testing delayed beyond Final Completion to test performance at peak seasonal conditions.
- B. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.
- C. Occupancy Sensitive Functional Performance Tests:
 - 1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
 - 2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

END OF SECTION

SECTION 230900

HVAC INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Control panel enclosures.
 2. Thermostats.
 3. Temperature Sensors.
 4. Freezestats.
 5. Control air dampers.
 6. Electric damper actuators.
 7. Control valves.
 8. Electric valve actuators.
 9. Direct digital control system components.
 10. Duct-mounted smoke detector.
 11. Differential pressure monitor.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.
- C. American Society of Mechanical Engineers:
1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ASTM International:
1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 2. ASTM A536 - Standard Specification for Ductile Iron Castings.
 3. ASTM B32 - Standard Specification for Solder Metal.
 4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 5. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
 6. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 7. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. National Electrical Manufacturers Association:
1. NEMA DC 3 - Residential Controls - Electrical Wall Mounted Room Thermostats.
 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. National Fire Protection Association:

1. NFPA 72 - National Fire Alarm Code.
2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

H. Underwriters Laboratories, Inc.:

1. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate operating data, system drawings, wiring diagrams, and written detailed operational description of sequences.
- B. Product Data: Submit description and engineering data for each control system component. Include sizing as required.
- C. Manufacturer's Installation Instructions: Submit installation requirements for each control component.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors.
- B. Operation and Maintenance Data: Submit inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

1.5 QUALITY ASSURANCE

- A. Control Air Damper Performance: Test in accordance with AMCA 500.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100.
- B. Installer: Company specializing in performing Work of this section with minimum three documented experience approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept controls on site in original factory packaging Inspect for damage.

1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of control system for three year from Date of Substantial Completion.
- B. Furnish complete service of controls systems, including callbacks. Perform minimum of 4 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls. Submit written report after each inspection.
- C. Furnish two complete inspections per year to inspect, calibrate, and adjust controls. Submit written report after each inspection.

- D. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
- E. Perform work without removing units from service during building normal occupied hours.
- F. Provide emergency call back service during working hours for this maintenance period.
- G. Maintain an adequate stock of parts for replacement or emergency purposes. Ensure personnel availability to ensure fulfillment of this maintenance service without unreasonable loss of time.
- H. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.
- I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

PART 2 PRODUCTS

2.1 CONTROL COMPONENT MANUFACTURERS

- A. Furnish for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on cabinet panel face. Contractor may elect to reuse existing panels where panels are found in acceptable conditions.
- B. Construction: NEMA 250, Type 4 steel enclosure.
- C. Covers: Continuous hinge, held closed by flush latch operable by key.
- D. Enclosure Finish: Manufacturer's standard enamel.

2.2 THERMOSTATS

- A. Outdoor Reset Thermostat:
 1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
 2. Scale range: -20 to 100 degrees F.
 3. Provide with lockable enclosure for all public areas.
- B. Electric Low Limit Duct Thermostat:
 1. Snap acting, single pole, single throw, manual reset switch tripping when temperature sensed across any 12 inches of bulb length is equal to or below set point.
 2. Bulb length: Minimum 20 feet.
 3. Furnish one thermostat for every 20 sq. ft of coil surface.

2.3 CONTROL AIR DAMPERS

- A. Manufacturers:
 1. Greenheck.
 2. Ruskin.
 3. Air Flow.

4. Vent Products.

- B. Performance: Test in accordance with AMCA 500.
- C. Frames: Extruded aluminum, Stainless steel, welded or riveted with corner reinforcement, minimum 12 gage.
- D. Blades: Extruded aluminum, Stainless steel, maximum blade size 5 inches, 48 inches long, minimum 22 gage, attached to minimum 1/2 inch shafts with set screws.
- E. Blade Seals: Neoprene mechanically attached, field replaceable.
- F. Jamb Seals: Stainless steel spring.
- G. Shaft Bearings: Lubricant free, stainless steel, single row, ground, flanged, radial, anti-friction type with extended inner race.
- H. Linkage Bearings: Graphite impregnated nylon.
- I. Outside Air Damper Leakage: Maximum leakage rate of 3.0 cfm per square foot at 1.0 inches wg pressure differential.
- J. Damper Leakage: Less than one percent based on approach velocity of 2000 fpm and 4 inches wg.
- K. Maximum Pressure Differential: 6 inches wg.
- L. Temperature Limits: - 40 to 200 degrees F.

2.4 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces).
 - 1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 3. Spring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Damper and Valve Actuators: Direct-coupled type designed for minimum 100,000 full-stroke cycles at rated torque.
 - 1. Valves: Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
 - 2. Dampers: Size for running torque calculated as follows.
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
 - e. Dampers with 2 to 3 Inches wg. of Pressure Drop or Face Velocities of 1000 to 2500 FPM Multiply the minimum full-stroke cycles above by 1.5.

- f. Dampers with 3 to 4 Inches wg. of Pressure Drop or Face Velocities of 2500 to 3000 FPM Multiply the minimum full-stroke cycles above by 2.0.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
6. Power Requirements (Two-Position Spring Return): 24V ac.
7. Power Requirements (Modulating): Maximum 15 VA at 24-V ac.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: -22F to 122°F.
10. Run Time: 200 seconds open, 40 seconds closed.

2.5 CONTROL VALVES

A. General:

1. Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 160 degrees F and modulating butterfly valves over 60 degrees F. Control valves, unless noted otherwise, shall be a minimum of one pipe size smaller than line size.
2. Control valves up to 6" shall be globe style unless otherwise noted.
3. Hydronic globe style control valves shall be ANSI Class IV rated for shutoff. All valves shall conform to ANSI B16.10 and ISA SP-75.
4. Heating valves shall be normally open and cooling valves shall be normally closed (or by-pass coil), unless noted otherwise on the drawings or in the control sequences.

B. Globe Pattern:

1. 2 inches and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with back seating capacity packable under pressure.
2. 2-1/2 inches and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of brass.
 - c. Sizing: Size for 3 psig maximum pressure drop at design flow rate.
 - d. Furnish two-way valves with equal percentage characteristics. Furnish three way valves with linear characteristics. Size two way valve actuators to close valves against pump shut off head.

C. Terminal Unit Control Valves:

1. Brass body, Class 250, nickel plated brass ball, with optimizer insert for modulating applications, blow out resistant stem, threaded ends.
2. Two or three way as indicated in schedule or on Drawings.
3. Integral actuator.
4. Spring return required for unit ventilator heating valves and other terminal equipment with outside air.
5. Furnish non-spring return valves with manual override capability built into actuator.
6. Minimum Fluid Temperature: 20 degrees F.
7. Maximum Operating Conditions: 250 degrees F.
8. Sizing: 4 psig maximum pressure drop at design flow rate, to close against pump shutoff head.
9. Flow Characteristics: Furnish two-way and three-way valves with equal percentage characteristics.

2.6 DIRECT DIGITAL CONTROL SYSTEM COMPONENTS

A. Temperature Sensors:

1. Type: Resistance temperature detector (RTD) or thermistor.
 2. Accuracy:
 - a. Plus or minus 1 degree F for standard applications. Where high accuracy is required, furnish accuracy of plus or minus 0.2 degrees F.
 - b. Sensing Accuracy: Plus or minus 0.5 degree F.
 - c. Display Accuracy and Resolution: Minimum of plus or minus 1 degree F.
 3. Built-in communications port.
 4. Space Sensors (Admin Area Only): Digital with LCD display, day-night override button, and set point slide adjustment override options. Set point slide adjustment capable of being software limited by automation system to limit amount of room adjustment.
 5. Temperature Sensors: Sensors shall have +/- 0.5 °F accuracy between 32 °F and 212 °F, 24V ac/dc power supply, 4-20mA, 0-10Vdc or 05-Vdc outputs compatible with BMS, Operating temperature range of 32 °F to 158 °F.
 6. Outside Air Sensors: Watertight inlet fitting, furnish with shield from direct sunlight.
 7. Duct Temperature Sensors:
 - a. Rigid or averaging type as indicated in sequence of operations. Averaging sensor minimum length: 5 feet in length.
 - b. Duct Cross Sections Greater Than 10 square feet: Furnish serpentine averaging element to sense stratified air temperatures.
 8. Piping Temperature Sensors: Furnish with separable brass well.
- B. Differential Pressure Switches:
1. Furnish as specified in sequences of operation for status purposes in air and water applications.
 2. Fully adjustable differential pressure settings.
 3. UL Listed, SPDT snap-acting, pilot duty rated (125 VA minimum).
 4. NEMA 250 Type 4 enclosure.
 5. Scale range and differential suitable for intended application.
- C. Static Pressure Sensor:
1. Non-directional sensor with suitable range for expected input, and temperature compensated.
 2. Accuracy: plus or minus 1 percent of full scale with repeatability of 0.5 percent.
 3. Output: 4 to 20 mA, 0-5 v DC, 0-10 v DC.
 4. Building Static Pressure Range: minus 0.1 to 0.1 inches water column, minus 0.25 to 0.25 inches water column, minus 0.5 to 0.5 inches water column, minus 1.0 to 1.0 inches water column, jumper selectable.
 5. Duct Static Pressure Range: 0 to 1 inches water column, 0 to 2.5 inches water column, 0 to 5 inches water column, 0 to 10 inches water column, jumper adjustable.
- D. Water Flow Switches:
1. Paddle type with stainless steel or bronze paddle.
 2. UL Listed, SPDT snap-acting with pilot duty rating (125 VA minimum).
 3. Appropriate scale range and differential adjustment.
 4. Adjustable sensitivity.
 5. NEMA 250 Type 1 enclosure.
 6. Furnish vapor proof type for chilled water applications.

2.7 DUCT-MOUNTED SMOKE DETECTOR

- A. Product Description: NFPA 72, ionization type with the following features:
1. Auxiliary SPDT relay contact.
 2. Key-operated normal-reset-test switch.
 3. Duct sampling tubes extending width of duct.
 4. Visual indication of detector actuation.

- 5. Duct-mounted housing.
- B. Furnish four-wire detector with separate power supply and signal circuits.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify air handling units and ductwork installation is complete and air filters are in place before installing sensors in air streams.
- B. Verify location of thermostats and other exposed control sensors with Drawings before installation.
- C. Verify building systems to be controlled are ready to operate.

3.2 INSTALLATION

- A. Install thermostats, space temperature sensors, and other exposed control sensors after locations are coordinated with other Work.
- B. Install thermostats, space temperature sensors, and other exposed control sensors 54 inches above floor. Align with light switches.
- C. Install freeze protection thermostats using flanges and element holders.
- D. Install outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide separable sockets for liquids and flanges for air bulb elements.
- F. Install thermostats in aspirating boxes in public areas, entrances and as indicated on Drawings.
- G. Install guards on thermostats in public areas, entrances.
- H. Install control panels adjacent to associated equipment on vibration free walls or freestanding supports. Use one cabinet for each system. Install engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face. Label with appropriate equipment or system designation.
- I. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- J. Provide cover plates for all devices removed by this work, where existing location is not being reused.
- K. Remove all devices rendered obsolete or non-functional by this work. This includes thermostats throughout the building made obsolete prior to this project. Verify operation of all thermostats prior to removal of replacement.
- L. Coordinate all locations required for network connections with the Owner.
- M. Existing temperature controls conduit can be reused where found in acceptable condition.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
- B. Replace damaged or malfunctioning controls and equipment.
 - 1. Start, test, and adjust control systems.
 - 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- C. Verify DDC as follows.
 - 1. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
 - 2. Verify operation of operator workstation.
 - 3. Verify local control units including self-diagnostics.

3.4 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide two Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

3.5 FIELD QUALITY CONTROL

- A. Provide the 24 hours of on-site or classroom training throughout the contract period for personnel designated by the Owner. Each session shall be a minimum of three hours in length and must be coordinated with the building Owner. Train the designated staff of Owners Representative and Owner to enable them to:
 - 1. Proficiently operate the system.
 - 2. Understand control system architecture and configuration.
 - 3. Understand DDC system components.
 - 4. Understand system operation, including DDC 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 set points, time schedules, and holiday schedules.
 - 9. Recognize malfunctions of the system by observation of the printed copy and graphical 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 DDC controllers.

END OF SECTION

SECTION 230923

DIRECT DIGITAL CONTROLS

PART 1 GENERAL

1.1 WORK INCLUDES

- A. Contractor shall provide control equipment and software as required for a complete and operational, control system.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI MC85.1 - Terminology for Automatic Control.

1.3 SYSTEM DESCRIPTION

- A. The Contractor shall provide a Building Automation system that will operate on the County of Kenosha's existing intranet system. The system shall be compatible with Schneider Electric EcoStruxure BACnet controller(s) as primary BAS controller(s). The new building controllers will integrate with the existing BAS with new server on Owner's network via the intranet.
- B. The new primary servers and controllers shall have capabilities to expand future equipment that will be installed in later phases.
- C. Existing building automation controls associated with equipment that is not being replaced in this phase must remain operational on existing BAS system until future phases of work is completed. At which point those controls will be eliminated and integrated into new EcoStruxure network.
- D. Schneider Electric controller(s) provided under this contract shall connect to field devices via BACnet/MSTP/IP field bus and provide all Building level integration/supervisory functionality. All control sequences shall therefore reside on building controller(s) in fully distributed control architecture.
- E. The Contractor shall surrender all programming files used in the project and shall guarantee that the products installed will be at current revisions, and provide updates for repairs made to software for 1 year.
- F. All controllers performing algorithmic calculations and control of the air-handling and other mechanical equipment shall have BACnet Class 3 performance as a minimum.
- G. The sequence of operation for every system shall be included in the Building Automation System on the same screen showing that system graphic.
- H. All BACnet devices shall include all hardware and software necessary to integrate the controls with the BACnet over Ethernet or IP network and meet the systems functional specification.
- I. Any BACnet device that exists on a common BACnet inter-network must have a unique address, referred to as its Device Instance. Coordinate the Device Instance numbering system with Owner.

- J. Mechanical equipment controllers shall be connected to the system through the local network to the system backbone, provide all BACnet System defined functionality for each piece of mechanical equipment,. The operator shall have direct access to all network devices at this point of entry.
- K. The HVAC temperature control hardware will be native BACnet. The native BACnet means that the database objects in the controller can be seen by other BACnet systems.
- L. All BACnet wiring must be shielded 22 AWG Level 4.
- M. Provide computer software, hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- N. Provide controls for air-handling units, variable air volume terminals, pre-heat and reheat coils, pumps, boilers and air-cooled condensers, exhaust fans, when directly connected to control units.
- O. Provide control systems consisting of thermostats, space temperature sensors, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.
- P. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate the following:
 1. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
 2. Connected data points, including connected control unit and input device.
 3. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations.
 4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 5. Description and sequence of operation for operating, user, and application software.
 6. Use terminology in submittals conforming to ASME MC85.1.
- B. Product Data: Submit data for each system component and software module.
- C. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.
- D. Qualifications: Submit proof of manufacturer, installer, and programmer qualifications.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 1. Revise shop drawings to reflect actual installation and operating sequences.
 2. Submit data specified in "Submittals" in final "Record Documents" form.
- B. Operation and Maintenance Data:
 1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered system components and devices.
 2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.

3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.6 QUALIFICATIONS

- A. Manufacturer: Schneider Electric.
- B. Installer: Kain Energy, Waukesha, WI.
- C. Programmer: Individual(s) certified in Schneider Electric product programming and must be resident employee from an office within 100 miles of the jobsite.

PART 2 PRODUCTS

2.1 DIRECT DIGITAL CONTROLS

- A. Manufacturers:
 1. Schneider Electric, StruxureWare.

2.2 NEW FILE SERVER WORKSTATION

- A. Provide new laptop file server.
- B. Workstation Client Hardware Stations: The system shall be capable of supporting at least 10 clients (minimum of 5 simultaneous users) using a standard Web browser such as Internet Explorer™ operating on any standard computer that supports the current version of Internet Explorer™.
- C. Personal Computer: IBM Laptop compatible with sufficient memory and hard drive storage to support graphics, reports, and communication requirements. Furnish with the following minimum configuration requirements:
 1. Processor: Intel Xeon E-1620, 3.5 GHz FSB.
 2. Hard Drive: 1 Terabyte.
 3. Memory: 8 Gigabyte DDR SDRAM.
 4. Drive 1: Sata DVD-ROM.
 5. Modem: Auto-dial telephone, 56,000 baud.
 6. Ports: Required serial, parallel, network communications, 4-USB, and cables for proper system operation.
 7. Expansion Slots: 1 used for LAN card, 1 available.
 8. LAN Card: Ethernet - RJ45 (100 base-T minimum).
 9. Graphics: Super video graphic adapter (SVGA), minimum 1024 x 768 pixels, 2.0-MB EDO video memory.
 10. Tape Backup: 8X RW-CD, minimum.
 11. Screen: Minimum of 17 inch color.
 12. Operating System: Windows 10.
- D. Server Application Software: Include the following:

Input/output capability from operator station for monitoring and controlling all of the points listed in the input/output point list. The operator shall be able to monitor and access all points by means of clear concise English names without having to understand or reference hardware point locations or controller programs.

1. The server 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-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and 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.
2. Real-Time Displays. The server, shall at a minimum, support the following graphical features and functions:
 - a. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the server shall support the use of scanned pictures.
 - b. Graphic screens shall contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
 - c. Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.
 - d. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - (1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - (2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
3. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
4. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
5. System Configuration. At a minimum, the server shall permit the operator to perform the following tasks, with proper password access:
 - a. Create, delete or modify control strategies.
 - b. Add/delete objects to the system.
 - c. Tune control loops through the adjustment of control loop parameters.
 - d. Enable or disable control strategies.
 - e. Generate hard copy records or control strategies on a printer.
 - f. Select points to be alarmable and define the alarm state.
 - g. Select points to be trended over a period of time and initiate the recording of values automatically.
6. 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.
7. 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 have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
8. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
9. Database Backup and Restore. The system shall automatically back up each Universal Network Controller's (UNC) database on a defined frequency. If the system senses a loss of a UNC database,

the Workstation shall automatically download and restore the archived database to the subject controller.

10. Archiving/Relational Database. The system shall provide a full relational database (ODBC, SQL or IBM) supporting multiple user access. Standard SQL Query statements shall be supported for access. All logs, alarms and operator commands/actions shall be automatically archived to the relational database. Database shall be ODBC compliant database or must be capable of supporting an ODBC data access mechanism to read and write data stored within it.
 11. Alarm Console
 - a. The system will be provided with 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 acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
- E. 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.
- F. Web Browser Clients
1. The system shall be capable of supporting at least 10 clients using a standard Web browser such as Internet Explorer™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, are only acceptable if 64 licensed copies of the client machine software are provided, installed, and tested.
 2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall only be acceptable if 10 workstation or workstation hardware upgrades are provided.
 3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
 4. The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. Graphical screens developed for the server shall be the same screens used for the Web browser client. Any animated graphical objects supported by the server shall be supported by the Web browser interface.
 - c. 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.
 - d. Storage of the graphical screens shall be in the Building Control Units, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - e. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
 - f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - (1)Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

- (2) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
- (3) View logs and charts
- (4) View and acknowledge alarms
- g. The system shall provide the capability 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 their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- h. Graphic screens 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. As a minimum they shall include link to locations for fan/motors/belt information, air filter information, building plan files etc.

2.3 BACnet Controller (BCx1)

- A. The BCx1 shall provide the interface between the field control devices, and provide global supervisory control functions over the control devices connected to the BCx1. It shall be capable of executing application control programs to provide:
 - 1. Calendar functions.
 - 2. Scheduling.
 - 3. Trending.
 - 4. Alarm monitoring and routing.
 - 5. Time synchronization by means of an Atomic Clock Internet site including automatic synchronization.
 - 6. Integration of BACnet controller data.
- B. The BCx1 must provide the following hardware features as a minimum:
 - 1. One Ethernet Port – 10/100 Mbps.
 - 2. One RS-232 port.
 - 3. Battery Backup.
 - 4. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity).
- C. BCx1 shall provide the capability for multiple user access to the system and support for relational database access (ODBC, SQL or IBM). A database resident on the BCx1 shall be ODBC compliant database or must be capable of supporting an ODBC data access mechanism to read and write data stored within it.
- D. BCx1 shall provide the capability to support standard Web browser access via the Intranet/Internet. It shall support a minimum of 5 simultaneous users.
- E. Event Alarm Notification and actions:
 - 1. The BCx1 shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - 2. The BCx1 shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
 - 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - 4. To alarm
 - 5. Return to normal
 - 6. To fault
 - 7. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and classes of alarms, i.e.: security, HVAC, Fire, etc.
 - 8. Provide timed (schedule) routing of alarms by class, object, group, or node.

9. 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.
 10. Control equipment and network failures shall be treated as alarms and annunciated.
 11. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text
 - b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - 1) Day of week
 - 2) Time of day
 - 3) Recipient
 12. Pagers via paging services that initiate a page on receipt of email message.
 13. Graphic with flashing alarm object(s).
 14. Printed message, routed directly to a dedicated alarm printer.
 15. The following shall be recorded by the BCx1 for each alarm (at a minimum):
 - a. Time and date
 - b. Location (building, floor, zone, office number, etc.)
 - c. Equipment (air handler #, pump #, etc.)
 - d. Acknowledge time, and date, and user who issued acknowledgement.
 - e. Number of occurrences since last acknowledgement.
 16. Alarm actions may be initiated by user defined programmable objects created for that purpose.
 17. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
 18. A log of all alarms shall be maintained by the UNC and/or a server (if configured in the system) and shall be available for review by the user.
 19. Provide a “query” feature to allow review of specific alarms by user defined parameters.
 20. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
 21. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- F. Data Collection and Storage
1. The UNC shall have the ability to collect data for any property of any object and store this data for future use.
 2. The data collection shall be performed by log objects, resident in the UNC that shall have, at a minimum, the following configurable properties:
 - a. Designating the log as interval or deviation.
 - b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - d. 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.
 - e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
- G. All log data shall be stored in a relational database in the BCx1 and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.
- H. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- I. All log data shall be available to the user in the following data formats:
1. HTML

2. XML
 3. Plain Text
 4. Comma or tab separated values
- J. Systems that do not provide log data in HTML and XML formats at a minimum shall provide as an alternative Microsoft SQL Server®, Oracle 8i or Express®, Hyperion Solutions™ SQL Server.
- K. The UNC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other UNC on the network. Provide the ability to configure the following archiving properties, at a minimum:
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
- L. AUDIT LOG
1. Provide and maintain an Audit Log that tracks all activities performed on the UNC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the UNC), to another UNC on the network, or to a server. For each log entry, provide the following data:
 - a. Time and date
 - b. User ID
 - c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
- M. DATABASE BACKUP AND STORAGE
1. The UNC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
 2. Copies of the current database and, at the most recently saved database shall be stored in the UNC and in the primary Server. The age of the most recently saved database is dependent on the user-defined database save interval.
 3. The UNC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.4 LOCAL AREA NETWORKS (LAN):

- A. Capacity for a minimum of 10 client workstations connected to multiuser, multitasking environment with concurrent capability to access DDC network or control units.
1. Enterprise Network LAN
 - a. Media: Ethernet (IEEE 802.3), peer-to-peer CSMA/CD, operating at 10 or 100 Mbps, cable 10 Base-T, UTP-8 wire, category 5
 2. Remote Connection
 - a. ISDN, ADSL, T1 or dial-up connection, monthly charges paid by building owner

2.5 CUSTOM APPLICATION CONTROL UNITS (CAC):

- A. Modular, comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control applications. CAC's shall be provided for Roof Top Units, Boiler Plant, Chiller Plant and other applications as shown on drawings and shall have device resource files and external interface definitions:
1. Units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, enthalpy calculation, counters, interlocks, ramps, drivers, schedules, calendars, OSS, compare, limit, curve fit, and alarms.

2. Stand alone mode control functions operate regardless of network status. Functions include the following:
 - a. Automatic communications loss detection to maintain normal control functionality regardless of available network communications.
 - b. Discrete/digital, analog, and pulse input/outputs.
 - c. Monitoring, controlling, or addressing data points.
 - d. Local energy management control strategies.
- B. Local operator interface port provides for download from and connection to portable workstation.
- C. Communication: The Custom Application Controller shall communicate via the Primary Controller Network between BMS Controllers. CAC's shall communicate with the UNC's and ASC's at a baud rate of not less than 78.8K baud using communications protocol (EIA 709.1).
- D. All CAC's shall support the portable workstation to provide uploading/downloading of Custom Application Controller databases, monitoring of all Standard Network Variables Types (SNVTs) including display of all bound SNVTs, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules. POT connectivity shall be via digital wall sensor connected to controller.
- E. The Controls Contractor shall provide a Data Table showing all DDC points and information pertaining to all points. The tables shall reference points with respect to the names established on the project drawings and specifications.
- F. The Controls Contractor shall provide network cable to the Integrator's Universal Network Controller by leaving minimum of 10' of coiled cable at the NCU. Final connection to the NCU will be by the Integrator.

2.6 APPLICATION SPECIFIC CONTROL UNITS: (ASC)

- A. Single board construction comprising processor board with programmable, nonvolatile, RAM/EEPROM memory for custom control and unitary applications. ASCs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, VAV Terminal Boxes, Rooftop Units and other applications as shown on the drawings. ASCs shall be based on the Echelon Neuron 3150 microprocessor working with the ASCs stand alone control program.
 1. Units monitor or control each input/output point; process information; and download from the operator station.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Peer to peer primary network level communications with automatic communications loss detection to maintain normal control functionality regardless of available network communications.
 - b. Discrete/digital, analog, and pulse input/output.
 - c. Monitoring, controlling, or addressing data points.
 3. The local operator interface ports located on ASC and ASC sensors provide for download from, or upload to portable workstation.
 4. Communication: ASC's shall communicate with the UNC's and CAC's at a baud rate of not less than 78.8K baud using communications protocol (EIA 709.1).
 5. ASC units monitor or control each input/output point; process information; and at least 50 expressions for customized HVAC control including mathematical equations, boolean logic, PID control loops with anti-windup, sequencers, timers, interlocks, thermostats, counters, interlocks, compare, limit, and alarms.
 6. All ASC Controller setpoints shall be digital display setpoints with dual setpoint limits (integral hard limits which the user cannot exceed above and below and independent soft limits which are hidden

from the user). All digital setpoints shall be network retentive after power outages and after replacement of sensor.

7. All ASC's shall support the portable workstation to provide uploading/downloading of Application Specific Controllers databases, Standard Network Variables Types (SNVTs) including display of all bound SNVTs, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules. POT connectivity shall be via digital wall sensor connected to controller.

2.7 HVAC CONTROL PROGRAMS

A. General:

1. Use Inch-pound measurement and have S.I. (metric) units of measurement available.
2. Identify each HVAC Control system.

B. Optimal Run Time:

1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
4. Use outside air temperature to determine early shut down with ventilation override.
5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
6. Operator commands:
 - a. Define term schedule.
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.
 - e. Define heating/cooling parameters.
 - f. Define mass sensor heating/cooling parameters.
 - g. Lock/unlock program.
 - h. Request optimal run-time control summary.
 - i. Request optimal run-time mass temperature summary.
 - j. Request HVAC point summary.
 - k. Request HVAC saving profile summary.
7. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run-time system normal start-times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
8. Mass temperature summary:
 - a. Mass temperature point type and ID.
 - b. Desired and current mass temperature values.
 - c. Calculated warm-up/cool-down time for each mass temperature.
 - d. Heating/cooling season limits.
 - e. Break point temperature for cooling mode analysis.
9. HVAC point summary:
 - a. Control system identifier and status.
 - b. Point ID and status.

- c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and status.
 - e. Calculated optimal start and stop times.
 - f. Period start.
- C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems and single zone unit discharge temperatures.
 2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
 - a. Raising cooling temperatures to highest possible value.
 - b. Reducing heating temperatures to lowest possible level.
 3. Operator commands:
 - a. Add/delete fan status point.
 - b. Lock/unlock program.
 - c. Request HVAC point summary.
 - d. Add/Delete discharge controller point.
 - e. Define discharge controller parameters.
 - f. Add/delete air flow rate.
 - g. Define space load and load parameters.
 - h. Request space load summary.
 4. Control summary:
 - a. HVAC control system status (begin/end).
 - b. Supply air reset system status.
 - c. Optimal run time system status.
 - d. Heating and cooling loop.
 - e. High/low limits.
 - f. Deadband.
 - g. Response timer.
 - h. Reset times.
 5. Space load summary:
 - a. HVAC system status.
 - b. Optimal run time status.
 - c. Heating/cooling loop status.
 - d. Space load point ID.
 - e. Current space load point value.
 - f. Control heat/cool limited.
 - g. Gain factor.
 - h. Calculated reset values.
 - i. Fan status point ID and status.
 - j. Control discharge temperature point ID and status.
 - k. Space load point ID and status.
 - l. Airflow rate point ID and status.

2.8 PROGRAMMING APPLICATION FEATURES

- A. Trend Point:
1. Output trend logs as line-graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern and color, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.
- B. Alarm Messages:
1. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totaled point's warning limit, hardware elements advisories.

2. Output assigned alarm with "message requiring acknowledgment".
 3. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.
- C. Weekly Scheduling:
1. Automatically initiate equipment or system commands, based on selected time schedule for points specified.
 2. Program times for each day of week, for each point, with one minute resolution.
 3. Automatically generate alarm output for points not responding to command.
 4. Allow for holidays, minimum of 366 consecutive holidays.
 5. Operator commands:
 - a. System logs and summaries.
 - b. Start of stop point.
 - c. Lock or unlock control or alarm input.
 - d. Add, delete, or modify analog limits and differentials.
 - e. Adjust point operation position.
 - f. Change point operational mode.
 - g. Open or close point.
 - h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
 - i. Begin or end point totals.
 - j. Modify total values and limits.
 - k. Access or secure point.
 - l. Begin or end HVAC or load control system.
 - m. Modify load parameter.
 - n. Modify demand limiting and duty cycle targets.
 6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.
- D. Interlocking:
1. Permit events to occur, based on changing condition of one or more associated master points.
 2. Binary contact, high/low limit of analog point or computed point capable of being used as master. Master capable of monitoring or commanding multiple slaves.
 3. Operator commands:
 - a. Define single master/multiple master interlock process.
 - b. Define logic interlock process.
 - c. Lock/unlock program.
 - d. Enable/disable interlock process.
 - e. Execute terminate interlock process.
 - f. Request interlock type summary.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify conditioned power supply is available to control units. Locate existing electrical power panels and add 15 amp single pole breakers as required to power new controls. Use lightly loaded circuits where space in panels is not available. Label all circuits that feed controls.
- B. Verify field end devices and wiring is installed prior to installation proceeding.

3.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units. Implement features of programs to specified requirements and appropriate to sequence of operation.
- C. Install with 120 volts alternating current, 15 amp dedicated power circuit to each programmable control unit.
- D. Install conduit and electrical wiring in accordance with Division 26.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Complete a Pre-functional Checklist for each piece of equipment and each controls system installed as a part of this work.
- C. Furnish service technician employed by system installer to instruct Owner's representative in operation of systems plant and equipment for 16 hour period within one calendar week as follows:
 - 1. Four hours of classroom training for not less than four of the owner's staff.
 - 2. Four hours of field training of control components and instrumentation including location and function of devices for not less than four of the owner's staff.
 - 3. Four hours of training and assistance programming the time of day schedules for equipment (Contractor shall be responsible for programming final schedules).
 - 4. Four hours of follow-up training to be used at the owner's discretion.
- D. Furnish service technician employed by system installer to provide a two hour site visit at a time that approaches full cooling load to review the system operation with the owner.
- E. Furnish service technician employed by system installer to provide a two hour site visit at a time that approaches full heating load to review the system operation with the owner.
- F. Furnish service technician employed by system installer to assist the Commissioning Agent in the Functional Testing of the operation of systems plant and equipment until the System Commissioning is complete.

3.4 DEMONSTRATION AND TRAINING

- A. Demonstrate complete and operating system to Owner.

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Natural gas piping above grade.
 2. Unions and flanges.
 3. Valves.
 4. Pipe hangers and supports.
 5. Strainers.
 6. Natural gas pressure regulators.

1.2 REFERENCES

- A. American National Standards Institute:
1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
- B. American Society of Mechanical Engineers:
1. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
 2. ASME B31.9 - Building Services Piping.
 3. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- C. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 5. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- D. National Fire Protection Association:
1. NFPA 54 - National Fuel Gas Code.
- E. Underwriters Laboratories Inc.:
1. UL 842 - Valves for Flammable Fluids.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.9, ASTM F708.

- D. Use plug, or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - a. Strainers.
 - b. Natural gas pressure regulators.
 - c. Natural gas pressure relief valves.
- B. Test Reports: Indicate results of piping system pressure test.
- C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves, piping system, and system components.
- B. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists.

1.6 QUALITY ASSURANCE

- A. Perform natural gas Work in accordance with NFPA 54.
- B. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- C. Perform Work in accordance applicable code for welding hanger and support attachments to building structure.
- D. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inches and smaller; welded for pipe 2-1/2 inches and larger. Socket welded for concealed joints.

2.2 REGULATOR VENT PIPING, ABOVE GRADE

- A. Indoors: Same as natural gas piping, above grade.
- B. Outdoors: Same as natural gas piping, above grade.

2.3 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.

2.4 BALL VALVES

- A. Manufacturers:
 - 1. Crane Valve, North America
 - 2. Hammond Valve
 - 3. Milwaukee Valve Company
 - 4. NIBCO, Inc.
 - 5. Stockham Valves & Fittings
- B. 1/4 inch to 1 inch: Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, full port.
- C. 1-1/4 inch to 3 inch: Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, conventional port.

2.5 PLUG VALVES

- A. Manufacturers:
 - 1. DeZURIK, Unit of SPX Corp.
 - 2. Flow Control Equipment, Inc.
 - 3. Homestead Valve
- B. 2 inches and Smaller: Class 150, semi-steel construction, square port, regular opening, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.

2.6 STRAINERS

- A. Manufacturers:
 - 1. Mueller Steam Specialty
 - 2. O.C. Keckley Company
- B. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.7 NATURAL GAS PRESSURE REGULATORS

- A. Manufacturers:
 - 1. Fisher.
 - 2. Maxitrol.
 - 3. Sensus.
 - 4. JordanValve.
 - 5. Tracpipe.
- B. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
 - 1. Comply with ANSI Z21.80.
 - 2. Temperatures: minus 20 degrees F to 150 degrees F.
 - 3. Body: Cast iron.
 - 4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
 - 5. Disk, diaphragm, and O-ring: Nitrile.
 - 6. Maximum inlet pressure: 150 psig.
 - 7. Furnish sizes 2 inches and smaller with threaded ends.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.

- D. Where required, bend pipe with pipe bending tools in accordance with procedures intended for that purpose.
- E. Install piping to conserve building space and not interfere with use of space.
- F. Size and install gas piping to provide sufficient gas to supply maximum appliance demand at pressure higher than appliance minimum inlet pressure.
- G. Group piping whenever practical at common elevations.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Sleeve pipe passing through partitions, walls and floors.
- J. Provide clearance for installation of insulation and access to valves and fittings.
- K. Provide access where valves and fittings are not exposed.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- M. Provide support for utility meters in accordance with requirements of utility company.
- N. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood. Protect vent against entry of insects and foreign material.
 1. Minimum Vent Size: Connection size at regulator vent connection.
 2. Run individual vent line from each relief device, independent of breather vents.
- O. Breather vents may be manifolded together with piping sized for combined appliance vent requirements.
- P. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting.
- Q. Install valves with stems upright or horizontal, not inverted.
- R. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- S. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.
- T. All piping exterior of the building shall be provided with epoxy coating. Color to match the City of Evanston standards.

3.4 FIELD QUALITY CONTROL

- A. Where gas appliance will be damaged by test pressure, disconnect appliance and cap piping during pressure test. Reconnect appliance after pressure test and leak test connection.
- B. Where gas appliance is designed for operating pressures equal to or greater than piping test pressure, provide gas valve to isolate appliance or equipment from gas test pressure.
- C. Pressure test natural gas piping in accordance with NFPA 54.
- D. Where new branch piping is extended from existing system, pressure test new branch piping only. Leak test joint between new and existing piping with noncorrosive leak detection fluid or other approved method.

- E. When pressure tests do not meet specified requirements, remove defective work, replace and retest.
- F. Immediately after gas is applied to a new system, or a system has been restored after gas service interruption, check pipe for leakage.
 - 1. Where leakage is detected, shut off gas supply until necessary repairs are complete.
- G. Do not place appliances in service until leak testing and repairs are complete.

END OF SECTION

SECTION 232113

HYDRONIC PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Heating water piping, above ground.
 2. Equipment drains and over flows.
 3. Unions and flanges.
 4. Valves.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
 2. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 3. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 4. ASME B31.9 - Building Services Piping.
 5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 3. ASTM B32 - Standard Specification for Solder Metal.
 4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- C. Use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Use balancing valves for throttling, bypass, or manual flow control services.
- E. Use spring loaded check valves on discharge of hot water pumps.
- F. Use lug end butterfly valves in heating water systems.

- G. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
- B. Test Reports: Indicate results of piping system pressure test.
- C. Welders' Certificate: Include welders' certification of compliance with AWS D1.1.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves, equipment and accessories.
- B. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 HEATING WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
 - 1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.
- B. Copper Tubing: ASTM B88, Type L, drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tubing: ASTM B88, Type DWV, L, drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.

2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.3 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 1. Copper Piping: Class 150, bronze unions with brazed joints.
 2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 1. Ferrrous Piping: Class 150, forged steel, slip-on flanges.
 2. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.4 GATE VALVES

- A. Manufacturers:
 1. Crane Valve, North America
 2. Hammond Valve
 3. Milwaukee Valve Company
 4. NIBCO, Inc.
 5. Stockham Valves & Fittings
 6. Or equal
- B. 2 inches and Smaller: Class 125, bronze body, bronze trim, union bonnet, non-rising stem, inside screw with back-seating stem, solid wedge disc, solder or threaded ends.
- C. 2-1/2 inches and Larger: Class 125, cast iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.5 GLOBE VALVES

- A. Manufacturers:
 1. Crane Valve, North America
 2. Hammond Valve
 3. Milwaukee Valve Company
 4. Nibco, Inc.
 5. Stockham Valves and Fittings
 6. Or equal
- B. 2 inches and Smaller: Class 125, bronze body, bronze trim, union bonnet, hand wheel, teflon composition disc, solder or threaded ends.
- C. 2-1/2 inches and Larger: Class 125, cast iron body, bronze trim, hand wheel, outside screw and yoke, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.6 BALL VALVES

- A. Manufacturers:
 1. Crane Valve, North America
 2. Hammond Valve
 3. Milwaukee Valve Company

4. NIBCO, Inc.
5. Stockham valves and fittings
6. Or equal

B. 2 inches and Smaller: Class 150, bronze, three piece body, stainless steel ball, full port, teflon seats, blow-out proof stem, solder or threaded ends, lever handle with balancing stops.

2.7 BALANCING VALVES

A. Manufacturers:

1. Tour and Anderson STAD
2. Wheatley GS Series
3. Armstrong CBV Series
4. Or equal

B. 2 inches and Smaller: Class 150 brass construction, female thread, Y-pattern globe style, minimum 5 turn, concealed locking balance point, flow measurement ports.

C. 2-1/2 inches and Larger: Class 150 cast iron construction, flanged, Y-pattern globe style, minimum 5 turn, concealed locking balance point, flow measurement ports.

2.8 BUTTERFLY VALVES

A. Manufacturers:

1. Crane Valve, North America
2. Hammond Valve
3. Milwaukee Valve Company
4. NIBCO, Inc.
5. Stockham valves and fittings
6. Or equal

B. 2-1/2 inches and Larger: Class 150.

1. Body: Cast or ductile iron, lug ends, stainless steel stem, extended neck.
2. Disc: Aluminum bronze.
3. Seat: Resilient replaceable EPDM.
4. Handle and Operator: 10 position lever handle.

2.9 CHECK VALVES

A. Manufacturers:

1. Crane Valve, North America
2. Hammond Valve
3. Milwaukee Valve Company
4. NIBCO, Inc.
5. Stockham valves and fittings
6. Or equal

B. Horizontal Swing Check Valves:

1. 2 inches and Smaller: Class 150, bronze body and cap, bronze seat, Buna-N disc, solder or threaded ends.
2. 2-1/2 inches and Larger: Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.

- C. Spring Loaded Check Valves:
 - 1. 2 inches and Smaller: Class 250, bronze body, in-line spring lift check, silent closing, teflon disc, integral seat, solder or threaded ends.
 - 2. 2-1/2 inches and Larger: Class 125, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems.

3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install heating water piping in accordance with ASME B31.9.
- B. Route piping parallel to building structure and maintain gradient.
- C. Install piping to conserve building space, and not interfere with use of space.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipe passing through partitions, walls and floors.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide access where valves and fittings are not exposed.
- H. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- K. Install valves with stems upright or horizontal, not inverted.

3.4 FIELD QUALITY CONTROL

- A. Test heating water piping system in accordance with ASME B31.9.

END OF SECTION

SECTION 23 21 16
HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Pressure gages.
 2. Pressure gage taps.
 3. Thermometers.
 4. Thermometer supports.
 5. Test plugs.
 6. Flexible connectors.
 7. Air vents.
 8. Strainers.
 9. Balancing Valves.
 10. Relief valves.
 11. Glycol solution.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.
 2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

1.3 SUBMITTALS

- A. Product Data: Submit for manufactured products and assemblies used in this Project.
1. Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
 2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
 4. Submit electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of actual locations of components and instrumentation, flow controls.
- B. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

- A. Manufacturers:
 - 1. Trerice.
 - 2. Weiss.
 - 3. Taylor.
 - 4. Ametek.
- B. Gage: ASME B40.1, UL 393 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
 - 1. Case: Cast aluminum.
 - 2. Bourdon Tube: Phosphor bronze.
 - 3. Dial Size: 4-1/2 inch diameter.
 - 4. Mid-Scale Accuracy: One percent.
 - 5. Scale: Psi.

2.2 PRESSURE GAGE TAPS

- A. Ball Valve: Brass 1/4 inch NPT for 250 psi.
- B. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.
- C. Siphon: Brass, 1/4 inch NPT angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Trerice.
 - 2. Weiss.
 - 3. Taylor.
 - 4. Ametek.
- B. Thermometer: ASTM E1, red appearing mercury, lens front tube, cast aluminum case with enamel finish.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
 - 4. Accuracy: ASTM E77 2 percent.

5. Calibration: Degrees F.

2.4 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 TEST PLUGS

- A. 1/4 inch NPT or 1/2 inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:
 1. Neoprene core for temperatures up to 200 degrees F.
 2. Nordel core for temperatures up to 350 degrees F.
 3. Viton core for temperatures up to 400 degrees F.
- B. Test Kit:
 1. Carrying case, internally padded and fitted containing:
 - a. Two 2-1/2 inch diameter pressure gages.
 - 1) Scale range: 0 to 100 psi
 - b. Two gage adapters with 1/8 inch probes.
 - c. Two 1-1/2 inch dial thermometers.
 - 1) Scale range: 30 to 100 degrees F.
 - 2) Scale range: 100 to 200 degrees F.

2.6 FLEXIBLE CONNECTORS

- A. Manufacturers:
 1. Flexonics.
 2. Vibration Isolator.
 3. Mason.
- B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 300 psig.

2.7 AIR VENTS

- A. Manufacturers:
 1. Bell & Gossett.
 2. Taco.
 3. Amtrol.
 4. Armstrong.
- B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type: Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- D. Washer Type: Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.8 STRAINERS

- A. Manufacturers:
 - 1. Amtrol.
 - 2. Watts.
 - 3. Armstrong.
- B. Size 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.9 PUMP SUCTION FITTINGS

- A. Manufacturers:
 - 1. Bell & Gossett.
 - 2. Armstrong.
 - 3. Aurora.
- B. Fitting: Angle pattern, cast-iron body. Threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger. Rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blow-down tapping in bottom, gage tapping in side.

2.10 BALANCING VALVES

- A. Manufacturers:
 - 1. Bell & Gossett.
 - 2. Tour Anderson.
 - 3. Aurora.
 - 4. Nexus.
- B. Construction: Brass or bronze body with union on inlet, and outlet, temperature and pressure test plug on inlet and outlet.
- C. Calibration: Control within 5 percent of design flow over entire operating pressure.
- D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.11 RELIEF VALVES

- A. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

2.12 GLYCOL SOLUTION

- A. Inhibited propylene glycol and water solution mixed 35 percent glycol - 65 percent water, suitable for operating temperatures from 0 degrees F to 210 degrees F.

PART 3 EXECUTION

3.1 INSTALLATION - THERMOMETERS AND GAGES

- A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.
- B. Install gage taps in piping
- C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- F. Coil and conceal excess capillary on remote element instruments.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

- A. Locate test plugs adjacent to thermometers and thermometer sockets.
- B. Where large air quantities accumulate, provide enlarged air collection standpipes.
- C. Install manual air vents at system high points.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide 3/4" threaded end with hose connection.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide drain and hose connection with valve on strainer blow down connection.
- G. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
- I. Support pump fittings with floor mounted pipe and flange supports.
- J. Provide relief valves on pressure tanks, low-pressure side of reducing valves and expansion tanks.
- K. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- L. Pipe relief valve outlet to nearest floor drain.

M. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

3.3 FIELD QUALITY CONTROL

A. Test for strength of glycol and water solution and submit written test results.

B. Refill glycol from dedicated areas in mechanical room. Coordinate locations with owner prior to any fill or drain.

3.4 CLEANING

A. Clean and flush glycol system before adding glycol solution.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Refrigerant piping.
 - 2. Unions, flanges, and couplings.
 - 3. Refrigerant moisture and liquid indicators.
 - 4. Valves.
 - 5. Refrigerant strainers.
 - 6. Refrigerant filter-driers.
 - 7. Refrigerant expansion valves.

1.2 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 495 - Refrigerant Liquid Receivers.
 - 2. ARI 710 - Liquid-Line Driers.
 - 3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
 - 4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
 - 5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. American Society of Mechanical Engineers:
 - 1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 3. ASME B31.5 - Refrigeration Piping.
 - 4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- D. ASTM International:
 - 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 - 4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 - 5. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 - 6. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
- E. American Welding Society:
 - 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. Underwriters Laboratories Inc.:
 - 1. UL 429 - Electrically Operated Valves.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.
- C. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- B. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
 - a. Refrigerant moisture and liquid indicators.
 - b. Refrigerant strainers.
 - c. Refrigerant pressure regulators.
 - d. Refrigerant pressure relief valves.
 - e. Refrigerant filter-driers.
 - f. Refrigerant solenoid valves.
 - g. Refrigerant expansion valves.
 - h. Electronic expansion valves.
- C. Design Data: Indicate pipe size.
- D. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.
- B. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years [documented] experience.

- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, Type ACR hard drawn or annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 UNIONS, FLANGES, AND COUPLINGS

- A. 2 inches and Smaller:
 - 1. Copper Pipe: Bronze, soldered joints.
- B. 2-1/2 inches and Larger:
 - 1. Copper Piping: Bronze.
 - 2. Gaskets: 1/16 inch thick preformed neoprene.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.3 REFRIGERANT MOISTURE AND LIQUID INDICATORS

- A. Manufacturers:
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Co.
- B. Indicators:
 - 1. Port: Single, UL listed.
 - 2. Body: Copper or brass, flared or solder ends.
 - 3. Sight glass: Color-coded paper moisture indicator with removable element cartridge and plastic cap.

4. Maximum working pressure: 430 psig
5. Maximum working temperature: 200 degrees F.

2.4 VALVES

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Diaphragm Packless Valves:

1. UL listed, globe or angle pattern, forged brass body and bonnet solder or flared ends.
2. Phosphor bronze and stainless steel diaphragms, rising stem and hand wheel.
3. Stainless steel spring, nylon seats, disc with positive back seating.
4. Maximum working pressure: 500 psig.
5. Maximum working temperature: 275 degrees F.

C. Packed Angle Valves:

1. Forged brass, solder or flared ends.
2. Forged brass seal caps with copper gasket, rising stem and seat with back seating, molded stem packing.
3. Maximum working pressure: 500 psig.
4. Maximum working temperature: 275 degrees F.

D. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, [ntegral ball check valve, flared or solder ends.
2. Maximum working pressure: 500 psig.

E. Refrigerant Check Valves:

1. Manufacturers:
 - a. Alco Controls Div, Emerson Electric Co.
 - b. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - c. Sporlan Valve Co.
2. Globe Type:
 - a. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc.
 - b. Maximum working pressure: 425 psig.
 - c. Maximum working temperature: 300 degrees F.
3. Straight Through Type:
 - a. Spring, neoprene seat.
 - b. Maximum working pressure: 500 psig.
 - c. Maximum working temperature: 200 degrees F.

2.5 REFRIGERANT STRAINERS

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Straight Line or Angle Line Type:

1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass.
2. Maximum working pressure: 430 psig.

2.6 REFRIGERANT FILTER-DRIERS

- A. Manufacturers:
 1. Alco Controls Div, Emerson Electric Co.
 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 3. Sporlan Valve Co.
- B. Replaceable Cartridge Angle Type:
 1. Shell: ARI 710, UL listed, brass, removable cap, for maximum working pressure of 350 psig.
 2. Filter Cartridge: Pleated media with integral end rings, stainless steel support
 3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina.
- C. Permanent Straight Through Type:
 1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 350 psig.

2.7 REFRIGERANT EXPANSION VALVES

- A. Manufacturers:
 1. Alco Controls Div, Emerson Electric Co.
 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 3. Sporlan Valve Co.
- B. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, mechanical pressure limit (maximum operating pressure MOP feature), adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb and remote bulb well.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and oversized at part load.

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.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Route piping parallel to building structure and maintain gradient.

- B. Install piping to conserve building space, and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors.
- E. Install pipe identification.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- H. Flood refrigerant piping system with nitrogen when brazing.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- K. Install valves with stems upright or horizontal, not inverted.
- L. Insulate piping per contract documents.
- M. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.
- N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- O. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- P. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- Q. Provide electrical connection to solenoid valves.
- R. Fully charge completed system with refrigerant after testing.
- S. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- T. Install refrigerant piping in accordance with ASME B31.5.

3.3 INSTALLATION - REFRIGERANT SPECIALTIES

- A. Refrigerant Liquid Indicators:
 1. Install line size liquid indicators in main liquid line downstream of condenser.
 2. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
 3. Install line size liquid indicators downstream of liquid solenoid valves.
- B. Refrigerant Valves:
 1. Install service valves on compressor suction and discharge.
 2. Install gage taps at compressor inlet and outlet.

3. Install gage taps at hot gas bypass regulators, inlet and outlet.
 4. Install check valves on compressor discharge.
 5. Install check valves on condenser liquid lines on multiple condenser systems.
 6. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.
- C. Strainers:
1. Install line size strainer upstream of each automatic valve.
 2. Where multiple expansion valves with integral strainers are used, install single main liquid-line strainer.
 3. On steel piping systems, install strainer in suction line.
 4. Install shut-off valves on each side of strainer.
- D. Filter-Dryers:
1. Install permanent filter-dryers in low temperature systems.
 2. Install permanent filter-dryer in systems containing hermetic compressors.
 3. Install replaceable cartridge filter-dryer vertically in liquid line adjacent to receivers.
 4. Install replaceable cartridge filter-dryer upstream of each solenoid valve.
- E. Solenoid Valves:
1. Install in liquid line of systems operating with single pump-out or pump-down compressor control.
 2. Install in liquid line of single or multiple evaporator systems.
 3. Install in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

3.4 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.
- B. Pressure test refrigeration system with dry nitrogen to 200 psig.
- C. Repair leaks.
- D. Retest until no leaks are detected.

END OF SECTION

SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. System cleaner.
 - 2. Closed system treatment (water-Glycol solution).
 - 3. Test equipment.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- B. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.
- D. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
- B. Operation and Maintenance Data: Submit data on glycol chargers including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

PART 2 PRODUCTS

2.1 SYSTEM CLEANER

- A. Product Description: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tri-Poly phosphate and sodium molybdate.
- B. Biocide; chlorine release agents including sodium hypochlorite or calcium hypochlorite, or microbicides including quaternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

2.2 CLOSED SYSTEM TREATMENT (WATER-GLYCOL SOLUTION)

- A. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
- B. Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulfites.
- C. Conductivity enhancers [; phosphates or phosphonates].

2.3 TEST EQUIPMENT

- A. Furnish white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titration burettes and associated reagents.
- B. Furnish following test kits:
 - 1. Alkalinity titration test kit.
 - 2. Chloride titration test kit.
 - 3. Sulphite titration test kit.
 - 4. Total hardness titration test kit.
 - 5. Low phosphate test kit.
 - 6. Conductivity bridge, range 0 - 10,000 micro-ohms.
 - 7. Creosol red pH slide, complete with reagent.
 - 8. Portable electronic conductivity meter.
 - 9. High nitrite test kit.

PART 3 EXECUTION

3.1 PREPARATION

- A. Operate, fill, start and vent systems prior to cleaning. Use water meter to record capacity in each system. Place terminal control valves in open position during cleaning.

3.2 CLEANING

- A. Concentration:
 - 1. As recommended by manufacturer.
 - 2. One pound per 100 gallons of solution contained in the system.
 - 3. One pound per 100 gallons of solution for hot water systems.
- B. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and acceptance of Architect/Engineer.
- D. Flush glycol filled closed system with clean water for one hour minimum. Drain completely and refill.
- E. Remove, clean, and replace strainer screens.

- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

END OF SECTION

SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Duct Materials.
 2. Insulated flexible ducts.
 3. Single wall spiral round ducts.
 4. Transverse duct connection system.
 5. Casings.
 6. Ductwork fabrication.
 7. Kitchen hood exhaust ductwork fabrication.

1.2 REFERENCES

- A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 4. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 5. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
 6. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 7. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 8. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 9. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 10. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Air Duct Leakage Test Manual.
 2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- D. Underwriters Laboratories Inc.:
1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 SUBMITTALS

- A. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
 - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 - 2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
 - 3. Fittings.
 - 4. Reinforcing details and spacing.
 - 5. Seam and joint construction details.
 - 6. Penetrations through fire rated and other walls.
 - 7. Terminal unit, coil, and humidifier installations.
 - 8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- B. Product Data: Submit data for duct materials and duct connectors.
- C. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.
- D. Manufacturer's Installation Instructions: Submit special procedures for glass fiber ducts.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
- B. Construct ductwork to NFPA 90A standards.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures during and after installation of duct sealant.

PART 2 PRODUCTS

2.1 DUCT MATERIALS

- A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G60 (zinc coating) in conformance with ASTM A90/A90M.
- B. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- C. Fasteners: Rivets, bolts, or sheet metal screws, as recommended by duct manufacturer.

D. Hanger Rod: ASTM A36/A36M; galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 INSULATED FLEXIBLE DUCTS

A. Product Description: Two ply vinyl film supported by helical wound spring steel wire; fiberglass insulation; aluminized vapor barrier film.

1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -10 degrees F to 160 degrees F.
4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.3 SINGLE WALL SPIRAL ROUND DUCTS

A. Manufacturers:

1. McGill AirFlow Corporation
2. Semco Incorporated
3. Tangent Air Corp
4. Spiral Mfg. Co., Inc.

B. Product Description: UL 181, Class 1, round spiral duct constructed of galvanized steel or aluminum.

C. Self-sealing spiral duct with rubber O-ring at fittings. No exposed fasteners.

D. Construct duct with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	26
15 inches to 26 inches	24
28 inches to 36 inches	22
38 inches to 50 inches	20
52 inches to 84 inches	18

E. Construct fittings with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	24
15 inches to 26 inches	22
28 inches to 36 inches	20
38 inches to 50 inches	20
52 inches to 60 inches	18
62 inches to 84 inches	16

2.4 TRANSVERSE DUCT CONNECTION SYSTEM

A. Product Description: SMACNA "E" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.5 CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.
- B. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- C. Fabricate acoustic casings with reinforcing turned inward. Furnish 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb./cu ft minimum glass fiber media, on inverted channels of 16 gage.

2.6 DUCTWORK FABRICATION

- A. All ductwork installed in tunnel/crawl space shall be PVC coated and factory fabricated and finished.
- B. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.
- G. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
 - 1. Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
 - 2. Do not provide sealing products not bearing UL approval markings.

2.7 KITCHEN HOOD EXHAUST DUCTWORK FABRICATION

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.
- B. Exposed Kitchen Hood Exhaust Ducts: Construct of stainless steel ASTM A240/A240M OR ASTM 666, type 304 using continuous external welded joints.
- C. Concealed Kitchen Hood Exhaust Ducts: Construct of 16 gage carbon steel or 18 gage stainless steel ASTM A240/A240M OR ASTM 666, type 304 using continuous external welded joints.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

- A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inches and smaller.
- D. Use double nuts and lock washers on threaded rod supports.
- E. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- F. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.
- G. Ductwork installed in crawl space/tunnel shall be supported and installed per manufacturer's installation instructions.
- H. Repair scratches or damages to PVC coating per manufacturer's instructions and provide certifications of approval.
- I. For outdoor ductwork, protect ductwork, ductwork supports, linings and coverings from weather.
- J. Exhaust Outlet Locations:
 - 1. Minimum Distance from Property Lines: 3 feet.
 - 2. Minimum Distance from Building Openings: 5 feet.
 - 3. Minimum Distance from Outside Air Intakes: 10 feet.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.
- B. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- C. Connect air terminal units, air outlets and inlets to supply ducts directly or with five foot maximum length of flexible duct. Do not use flexible duct to change direction.

3.4 CONCEALED GREASE DUCT TESTING

- A. Prior to concealing, wrapping, or insulating grease ductwork, or placing grease duct in service, perform leakage test in accordance with ICC IMC, in presence of authority having jurisdiction.

- B. Perform light test by pulling minimum 100 W light through duct and observing for light leaks at duct joints.
- C. Test complete extent of duct installed, including joint at which duct connects to exhaust hood.

3.5 TESTING

- A. For ductwork designed for 3 inches w.c. above ambient, pressure test minimum 25 percent of ductwork after duct cleaning, but before duct insulation is applied or ductwork is concealed.
 - 1. Test in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
 - 2. Maximum Allowable Leakage: In accordance with ICC IECC.

3.6 SCHEDULES

- A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply	Galvanized Steel
Return and Relief	Galvanized Steel
General Exhaust	Aluminum
Kitchen Hood Exhaust	Steel, Stainless Steel

- B. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Variable Volume-Variable Temperature Supply	3 inch wg (regardless of velocity).
Return and Relief	1 inch wg regardless of velocity.
General Exhaust	1 inch wg regardless of velocity.
Kitchen Exhaust	3 inch wg regardless of velocity.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Volume control dampers.
 - 2. Flexible duct connections.
 - 3. Dynamic Fire Dampers.
 - 4. Duct test holes.
 - 5. Dial thermometers.
 - 6. Static pressure gages.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. ASTM International:
 - 1. ASTM E1 - Standard Specification for ASTM Thermometers.
- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 92A - Recommended Practice for Smoke-Control Systems.
- D. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- E. Underwriters Laboratories Inc.:
 - 1. UL 555 - Standard for Safety for Fire Dampers.
 - 2. UL 555S - Standard for Safety for Smoke Dampers.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.
- B. Product Data: Submit data for shop fabricated assemblies and hardware used.
- C. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
 - 1. Backdraft dampers.
 - 2. Flexible duct connections.
 - 3. Dynamic Fire Dampers.
 - 4. Volume control dampers.
 - 5. Duct access doors.
 - 6. Duct test holes.
- D. Product Data: For fire dampers, smoke dampers and combination fire and smoke dampers submit the following:
 - 1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.

2. Indicate materials, construction, dimensions, and installation details.
3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

E. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of access doors.
- B. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.5 QUALITY ASSURANCE

- A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
- B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.
- B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- C. Storage: Store materials in a dry area indoor, protected from damage.
- D. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

PART 2 PRODUCTS

2.1 BACK-DRAFT DAMPERS

- A. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, extruded aluminum. Blades, maximum 6 inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.2 DUCT ACCESS DOORS

- A. Manufacturers:
 1. Ruskin.
 2. Vent Products.
 3. Cesco Products.
 4. Greenheck.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
 1. Less than 12 inches square, secure with sash locks.
 2. Up to 18 inches Square: Furnish two hinges and two sash locks.
 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.

4. Larger Sizes: Furnish additional hinge.
5. Sash Lock.
6. Compression Latch.
7. Hinge.
8. Access panels with sheet metal screw fasteners are not acceptable.

2.3 DYNAMIC FIRE DAMPERS

- A. Manufacturers:
 1. Ruskin.
 2. Vent Products.
 3. Cesco Products.
 4. Greenheck.
- B. Fabricate in accordance with NFPA 90A and UL 555.
- C. Fire Resistance: Match fire rating of adjacent walls.
- D. Dynamic Closure Rating: Dampers classified for dynamic closure to 2000 fpm and 4 inches wg static pressure.
- E. Construction:
 1. Integral Sleeve Frame: Minimum 20 gage roll formed galvanized steel. Length: 12 inches.
 2. Blades:
 - a. Style: Curtain type.
 - b. Action: Spring or gravity closure upon fusible link release.
 - c. Material: Minimum 24 gage roll formed, galvanized steel.
 3. Closure Springs: Type 301 stainless steel, constant force type, if required.
- F. Fusible Link Release Temperature: 165 degrees F.
- G. Mounting: Vertical or horizontal.
- H. Duct Transition Connection, Damper Style:
 1. A style - rectangular connection, frame and blades in air stream.
 2. CR style - round connection, sealed.
 3. R style - round connection, blades in air stream, non-sealed.
- I. Finish: Mill galvanized.

2.4 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Splitter Dampers:
 1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw;
 4. Single Blade Dampers: Fabricate for duct sizes up to 48 x 48 inch.
- C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware;

- D. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg;
- E. Quadrants:
 - 1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.5 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Connector: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
 - 2. Net Fabric Width: Approximately 6 inches wide.
 - 3. Metal: 3 inch wide, 24 gage galvanized steel.
- C. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs. per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.6 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.7 DIAL THERMOMETERS

- A. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 3-1/2 inch diameter dial.
 - 2. Lens: Clear Lexan.
 - 3. Accuracy: 1 percent.
 - 4. Calibration: Degrees F

2.8 STATIC PRESSURE GAGES

- A. Manufacturers:
- B. Dial Gages: 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.
- C. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full scale accuracy.
- D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify rated walls are ready for fire damper installation.

- B. Verify ducts and equipment installations are ready for accessories.
- C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside.
- C. Access Doors: Install access doors at the following locations:
 - 1. Spaced every 50 feet of straight duct.
 - 2. Upstream of each elbow.
 - 3. Before and after each duct mounted filter.
 - 4. Before and after each duct mounted coil.
 - 5. Before and after each duct mounted fan.
 - 6. Before and after each automatic control damper.
 - 7. Before and after each fire damper, smoke damper and combination fire and smoke damper.
- D. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, Review locations prior to fabrication.
 - 1. Mark access doors for fire and smoke dampers on outside surface, with minimum 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, OR FIRE DAMPER.
- E. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- F. Install permanent duct test holes required for testing and balancing purposes.
- G. Install fire dampers, combination fire and smoke dampers and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
 - 1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
 - 2. Install dampers square and free from racking with blades running horizontally.
 - 3. Do not compress or stretch damper frame into duct or opening.
 - 4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
 - 5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.3 INSTALLATION - THERMOMETERS

- A. Install thermometers in air duct systems on flanges.
- B. Where thermometers are provided on local panels, duct mounted thermometers are not required.
- C. Locate duct-mounted thermometers minimum 10 feet downstream of mixing-dampers, coils, or other devices causing air turbulence.
- D. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.
- E. Provide instruments with scale ranges selected according to service with largest appropriate scale.

F. Install thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

G. Adjust thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.4 DEMONSTRATION

A. Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Downblast centrifugal roof fans.
 - 2. Upblast centrifugal roof fans.
 - 3. Energy recovery ventilator.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 - 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. American Refrigeration Institute:
 - 1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.
- D. ASTM International:
 - 1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
- E. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. Underwriters Laboratories Inc.:
 - 1. UL 705 - Power Ventilators.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.
- B. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.5 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- D. Balance Quality: Conform to AMCA 204.
- E. Energy Recovery Unit Wheel Energy Transfer Rating: Meet ARI 1060.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

PART 2 PRODUCTS

2.1 UPBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturers:
 - 1. Acme Engineering and Manufacturing Corp.
 - 2. Greenheck Corp.
 - 3. Loren Cook Company
 - 4. Penn Ventilation
- B. Fan Unit: Upblast type. V-belt or direct drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Open drip proof.
- E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.
- F. Accessories:
 - 1. Gravity backdraft damper.

2.2 DOWNBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturers:
 - 1. Acme Engineering and Manufacturing Corp.
 - 2. Greenheck Corp.
 - 3. Loren Cook Company

4. Penn Ventilation

- B. Fan Unit: Downblast type. V-belt or Direct drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor: Open drip proof.
- E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.
- F. Accessories:
 - 1. Gravity backdraft damper.

2.3 ENERGY RECOVERY VENTILATOR

- A. Manufacturers:
 - 1. RenewAire
 - 2. InspirAir
 - 3. Greenheck Corp.
- B. Unit Casing: Constructed of galvanized steel with bolted construction using corrosion resistant fasteners. Furnish with inlet and outlet duct collars. Double wall top, side and interior panels insulated with 1-1/2 inch, 3 pound per cubic foot density glass fiber insulation. Side panels hinged and removable for access to internal components. Enthalpy Core mounted in sliding track for access and cleaning. Fans and motor assembly mounted in sliding track for access.
- C. Enthalpy core: Total enthalpy type, capable of transferring both sensible and latent energy between airstreams. No condensate drains. Removable for servicing. AHRI Standard 1060.
- D. Fans: Individual supply and exhaust fans. Direct or Belt drive, single width, single inlet, forward curved, centrifugal blower with resilient mounted motor.
- E. Motors: Totally enclosed fan cooled with permanently lubricated sealed type bearings with ABMA 9 life at 200,000 hours.
- F. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position.
- G. Filter: 2 inch thick 30 percent efficient pleated type located in both supply and exhaust air streams.
- H. Electrical: Components factory wired for single point power connection. Control panel UL listed with access door.
- I. Controls: Microprocessor based control with factory installed BACnet controller interface and alarm outputs to BAS.
- J. Roof Curb: Combination Curb, See Drawings.
- K. Accessories:

1. Duct adapter for vertical discharge configuration.
 2. Intake weather hood with 2 inch washable aluminum filters.
 3. Exhaust weather hood with bird screen.
 4. Motorized dampers factory installed in supply and exhaust air streams.
 5. Disconnect Switch: NEMA 250 Type 3R enclosure.
 6. Rubber-in-shear type vibration isolators.
 7. VFD Fan controllers.
- L. Controls: Furnish unit with the following:
1. Manufacturer provided BACnet MSTP interface for contractor integration with microprocessor controller. All listed points to be added and controlled by a BAS system.
 2. Operation Sequence: See Drawings/Temperature control schematics.
 3. Minimum list of available points:
 - a. Outdoor air temperature sensor alarm
 - b. Outdoor air humidity sensor alarm
 - c. Exhaust air temperature sensor alarm
 - d. Exhaust air humidity sensor alarm
 - e. Outdoor air sensor alarm
 - f. Exhaust air sensor alarm
 - g. Dirty filter alarm
 - h. Supply and exhaust air proving alarm
 - i. Outside airflow sensor alarm
 - j. Exhaust airflow sensor alarm
 - k. Fan Status (Supply and Exhaust)
 - l. Fan Start/stop (Supply and Exhaust)
 - m. VFD Load (supply and Exhaust)
 - n. Damper positions (supply and exhaust)

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are instructed by manufacturer.

3.2 INSTALLATION

- A. Secure roof, wall fans and gravity ventilators with stainless steel lag screws to roof curb.
- B. Install backdraft dampers on inlet to roof.
- C. Provide backdraft dampers on outlet from cabinet and ceiling fans and as indicated on Drawings.
- D. Install safety screen where inlet or outlet is exposed.
- E. Pipe scroll drains to nearest floor drain.
- F. Provide sheaves required for final air balance.

3.3 PROTECTION OF FINISHED WORK

- A. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

3.4 FIELD QUALITY CONTROL

- A. Provide manufacturers factory start-up for all components.
- B. Provide owner training of at least 8 hours in 2 separate visits for ERVs.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Variable volume terminal units.
 - 2. Fan powered terminal units.

1.2 REFERENCES

- A. American Refrigeration Institute:
 - 1. ARI 880 - Air Terminals.
 - 2. ARI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- D. Underwriters Laboratories Inc.:
 - 1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 SUBMITTALS

- A. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, [heating coil capacity] and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.
- B. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of units.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

1.5 QUALITY ASSURANCE

- A. Test and rate air terminal units performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.

PART 2 PRODUCTS

2.1 SINGLE DUCT VARIABLE VOLUME AIR TERMINAL UNITS

- A. Manufacturers:
 - 1. Titus
 - 2. Price
 - 3. Trane
 - 4. Krueger
- B. Product Description: Variable air volume terminal units for connection to central air systems, with electronic controls, and hot water heating coils (where scheduled).
- C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.
- D. Basic Assembly:
 - 1. Casings: Minimum 22 gage galvanized steel.
 - 2. Lining: Minimum 3/4 inch thick neoprene or vinyl coated glass fiber insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with Mylar film.
 - 3. Plenum Air Inlets: Round stub connections for duct attachment.
 - 4. Plenum Air Outlets: S slip-and-drive connections.
- E. Basic Unit:
 - 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
 - 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches rated inlet static pressure.
 - 3. Damper operator shall be provided by the Temperature Controls Contractor and shipped to the factory for mounting. Mount damper operator to position damper normally open.
- F. Attenuation Section: Line attenuation sections with 2 inch thick insulation.
- G. Round Outlet: Discharge collar matching inlet size.
- H. Hot Water Heating Coil (Where specified):
 - 1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
 - 2. Capacity: As scheduled on drawings.
- I. Automatic Damper Operator:
 - 1. Electric Actuator: 24 volt with remote temperature read and reset capability.
- J. Sound Ratings: Not to exceed 30 NC at scheduled static pressure.

2.2 FAN POWERED VARIABLE VOLUME UNITS

- A. Manufacturers:
 - 1. Titus
 - 2. Price
 - 3. Trane
 - 4. Krueger

- B. Product Description: Variable air volume terminals for connection to central air systems with electronic controls and hot water heating coils.
- C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.
- D. Basic Assembly:
 - 1. Casings: Minimum 22 gage galvanized steel.
 - 2. Lining: Minimum 3/4 inch thick neoprene or vinyl coated glass fiber insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with Mylar film.
 - 3. Plenum Air Inlets: Round stub connections and S slip and drive connections for duct attachment.
 - 4. Plenum Air Outlets: S-slip and drive connections.
- E. Basic Unit:
 - 1. Configuration: Air volume damper assembly and fan in parallel arrangement inside unit casing. Locate control components inside protective metal shroud.
 - 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches inlet static pressure.
 - 3. Mount damper operator to position damper normally closed.
- F. Automatic Damper Operator:
 - 1. Electric Actuator: 24 volt with remote temperature read and reset capability.
- G. Fan Assembly:
 - 1. Fan: Forward curved centrifugal type with direct drive permanent-split-capacitor type, thermally protected motor.
 - 2. Speed Control: Infinitely adjustable with electric/pneumatic and electronic controls.
 - 3. Isolation: Fan/motor assembly on rubber isolators.
 - 4. Electrical Characteristics:
 - a. As scheduled on drawings.
- H. Hot Water Heating Coil:
 - 1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
 - 2. Capacity: Based on 190 degree F entering water, 170 degree F leaving water and total air volume as scheduled on drawings.
- I. Wiring:
 - 1. Factory mount and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
 - 2. Factory mount transformer for control voltage on electric and electronic control units. Furnish terminal strip in control box for field wiring of thermostat and power source.
 - 3. Wiring Terminations: Wire fan and controls to terminal strip. Furnish terminal lugs to match branch-circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box.
 - 4. Disconnect Switch: Factory mount fused disconnect switch on equipment.
- J. Controls: Electric Controls: Contain in NEMA 250 Type 1 enclosure with access panel sealed from airflow and mounted on side of unit.
- K. Thermostat: Per 23 09 23.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify ductwork is ready for air terminal installation.

3.2 INSTALLATION

- A. Install ceiling access doors or locate units above easily removable ceiling components.
- B. Support units individually from structure. Do not support from adjacent ductwork.
- C. Support air terminal units connected by flexible duct independently of flexible duct.
- D. Install transition piece to match flexible duct size to inlet or outlet of variable air volume terminal.
- E. Install minimum of 5 ft of 1 inch thick lined ductwork downstream of units.

3.3 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow. Set units with heating coils for minimum flow as indicated on the drawings.

3.4 DEMONSTRATION AND TRAINING

- A. Demonstrate operation and maintenance procedures.
- B. Furnish services for manufacturer's technical representative for one 8 hours day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner/Engineer. Provide at least 7 days notice to Engineer of training date.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof hoods.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.
- C. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

- A. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- B. Test Reports: Rating of air outlet and inlet performance.

1.4 QUALITY ASSURANCE

- A. Test and rate louver performance in accordance with AMCA 500.

PART 2 PRODUCTS

2.1 ROOF HOODS

- A. Manufacturers:
 - 1. Airline Products Co.
 - 2. Arrow United Industries
 - 3. Construction Specialties Inc.
 - 4. Greenheck Corp.
 - 5. Industrial Louvers Inc.
 - 6. Ruskin Manufacturing
- B. Fabricate air inlet or exhaust hoods in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Fabricate of reinforced galvanized steel, minimum 16 gage base and 20 gage hood, or aluminum, minimum 16 gage base and 18 gage hood. Furnish removable hood; bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory [prime coat] [baked enamel] finish.

- D. Fabricate hood outlet area minimum of twice throat area.
- E. Roof Curb: 16 inch high galvanized steel construction with continuously welded seams, built-in cant strips. 1 inch insulation and curb bottom, and factory installed nailer strip.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify inlet and outlet locations.

3.2 INSTALLATION

- A. Install per installation details.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 23 54 00
FUEL FIRED MAKE UP AIR UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fuel fired make-up air units (Kitchen).

1.2 REFERENCES

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- B. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.
 - 2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.
- B. Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Manufacturer's Installation Instructions: Submit rigging and assembly.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Maintain factory packaging in place until installation.
- B. Deliver accessories, fittings, valves, and other components in sealed containers and keep sealed until installation.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

PART 2 PRODUCTS

2.1 FUEL FIRED PACKAGED AIR UNITS – INDIRECT FIRED

- A. Manufacturers:
 - 1. Trane.
 - 2. Sterling.
 - 3. Greenheck.
 - 4. Hastings.

- B. Selection:
 1. Heating: In-Direct fired
 2. Airflow arrangement: Make-up Air
 3. Dampers: OA control dampers panel controlled actuators.
 4. Filters: 2" MERV 13, sized for intake opening.
 5. Unit arrangement: Down Discharge with Exhaust Fan.

- C. Cabinet
 1. Construction: Double wall with insulated metal cabinet. Exterior panels shall be 18 gauge galvanized steel using internal frame design. Base rails shall be 12 gauge galvanized steel.
 2. Internal Insulation: In accordance with NFPA 90A and tested to meet UL 181 erosion requirements.
 3. Exterior Unit Coating: Corrosion resistant polyester coating meeting a minimum 750 hours according to ASTM B117 with a max creep of no more than 1/16" from either side of the scribe and with not more than 1/8" total maximum.
 4. Access: Hinged doors.
 5. Unit Arrangement: Horizontal.
 6. Discharge Arrangement: Front discharge.

- D. Supply Air Fan
 1. Fan: Forward curved centrifugal fan; statically and dynamically balanced, mounted on frame/pad, polished steel fan shafts with permanently lubricated ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours at maximum cataloged speeds.
 2. Motor: Permanently lubricated, heavy duty type, matched to the fan load, with EPACT / NEMA Premium 12-11 Table rated efficiency, with a TEFC enclosure. Mounted on an adjustable slide base.
 3. Drives: V-Belt drive sized for a minimum of 150% of driven horsepower. Cast pulleys. Adjustable sheaves.
 4. Mounting: Fan and motor mounted internally isolated neoprene isolators.
 5. Air Flow Arrangement: Capability to be able to provide 100% OA. Operate in return air mode.
 6. Outlet Sound Power Level: Maximum 73 dBA at a distance of 5 feet from the discharge.

- E. Exhaust Fan
 1. Fan Unit: Upblast type. V-belt or direct drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
 2. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
 3. Motor: Open drip proof.

- F. In-Direct Fired Burner
 1. Description: Tubular stainless steel heat exchanger with welded construction.
 2. Single Furnace encased in weather-tight metal housing.
 3. Fuel: Natural gas with a maximum rated inlet gas pressure of 5 psi. Gas pressure regulator shall be provided.
 4. Temperature Control: Temperature control by an 8:1 Stage electronic modulating control. Amplifier to include a low fire time delay potentiometer and sensitivity potentiometer.
 5. Flue Material: Type B Stainless steel.
 6. Safety Controls:
 - a. Manual Reset, High Limit Switch: Main gas valve closes if high-limit temperature is exceeded.
 - b. Dual safety shutoff valves shall be provided that use 120 VAC control signals.

- G. Unit Options
 1. Mounting: Brackets, curbs, and attachments for mounting units with combo roof curb for exhaust fan.

- H. Electrical Controls
 - 1. Control Center: Contains magnetic motor starter, 24 VAC control transformers, integral master disconnect switch, flame safeguard, amplifier, and other required components to accomplish control functions. Discharge temperature control shall be factory mounting in unit. Coordinate right hand/ left hand access to the control center.
 - 2. Heating Inlet Air Sensor: Automatically turns the heat on and off based on a field adjustable set point.
 - 3. Access door interlock switch, alarm horn, low temperature limit, and clogged filter switch alarms.

- I. Dampers:
 - 1. Dampers: Outside dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper fail to closed position.
 - 2. Gaskets: Fit dampers with edge gaskets, maximum leakage 5 percent at 2 inches wg pressure differential.
 - 3. Damper Operator: 24 volt with gear train sealed in oil with spring return.

- J. Controls: Adjustable, room thermostat, low voltage, to control burner operation to maintain space temperature setting.
 - 1. Furnish interface to Direct Digital Control System. The unit shall be complete with communication interface that allows direct connection to the BACnet MSTP/IP network. The controls interface shall allow access by the Direct Digital Controls system to all internal points available within the unit that can be accessed by the unit manufacturer.
 - 2. Control Functions: Furnish the following:
 - a. Unit scheduling.
 - b. Occupied-unoccupied mode.
 - c. Start-up and coast-down modes.
 - d. Demand limiting.
 - e. Night setback.
 - f. Timed override.
 - g. Alarm shutdown.
 - h. Discharge air set point adjustment.
 - i. Static pressure setpoint adjustment.
 - 3. Furnish the following setpoints and diagnostic functions accessible in unit control panel:
 - a. Unit operating mode.
 - b. Unit failure status.
 - c. Supply fan start-stop.
 - d. Supply fan status.
 - e. Supply fan inlet guide vane position.
 - f. Supply air temperature.
 - g. Supply air temperature high-low limit with alarm.
 - h. Duct static pressure.
 - i. Duct static pressure high-low limit with alarm.
 - j. Heating control.
 - k. Heating status.
 - l. Damper control.
 - m. Damper positions.
 - n. Filter status.
 - o. Smoke detector status.
 - p. Outside air temperature.
 - q. Exhaust fan start-stop.
 - r. Exhaust fan status.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Provide manufacturer's factory start-up for all components.
- B. Provide owner training of at least 8 hours in 2 separate visits.

3.2 INSTALLATION

- A. Install units in accordance with NFPA 90A and gas fired units to NFPA 54.
- B. Installation - Natural Gas Piping:
 - 1. Connect natural gas piping in accordance with NFPA 54.
 - 2. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
 - 3. Install the following piping accessories on natural gas piping connections.
 - a. Strainer.
 - b. Pressure gage.
 - c. Shutoff valve.
 - d. Pressure reducing valve.
- C. Install vent connections in accordance with NFPA 211. Install vents and stacks.
- D. Install manufacturer's remote control panel per location shown on drawings.
- E. Install unit per manufacturer's instructions.

END OF SECTION

SECTION 23 74 13

PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes modular factory fabricated air-handling units and accessories.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
1. AMCA 99 - Standards Handbook.
 2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 5. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- C. Air-Conditioning and Refrigeration Institute:
1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
 2. ARI 430 - Central-Station Air-Handling Units.
 3. ARI 610 - Central System Humidifiers for Residential Applications.
 4. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.
- D. ASTM International:
1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.
- F. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- G. Underwriters Laboratories Inc.:
1. UL 900 - Air Filter Units.
 2. UL - Fire Resistance Directory.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- B. Product Data, Submit the following:
1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.

4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
5. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.
6. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.

C. Manufacturer's Installation Instructions: Submit.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 QUALITY ASSURANCE

- A. Outside Air Damper Leakage: Test in accordance with AMCA 500.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- B. Protect units from weather and construction traffic by storing in dry, roofed location.

PART 2 PRODUCTS

2.1 AIR HANDLING UNITS

- A. Manufacturers:
1. Trane
 2. Aeon
 3. Daikin
- B. Configuration: Fan section fan and coil section plus accessories, including:
1. Heating coil.
 2. Filter section.
 3. Combination filter/mixing box section.
 4. Face and Bypass Section.
 5. Mixing box section.
- C. Fabrication: Conform to AMCA 99 and ARI 430.
- D. Sound Data Provided shall be rated in accordance with AHRI 260.
- E. Roof Curb:
1. Factory assembled galvanized steel mounting curb designed and manufactured by unit manufacturer.
 2. Perimeter type with support of air handling sections.
 3. Furnish supply and return opening duct frames as part of curb structure allowing duct connections to be made directly to curb.
 4. Minimum of 16 inches high and include wood nailer strip.
 5. Furnish gaskets for field mounting.

2.2 CASING

- A. Channel base and drain pan of welded steel. Assemble sections with gaskets and bolts.
- B. Casing Panels provided with minimum thermal resistance R-13, with 2" double wall foam injected construction.
- C. Outside Casing:
 - 1. Galvanized Steel: 0.0516 inch.
 - 2. Seal fixed joints with flexible weather tight sealer. Seal removable joints with closed-cell foam gasket.
 - 3. Furnish cap strips over roof flanges. Furnish rain caps and gaskets on access doors.
- D. Outside Casing Finish:
 - 1. Baked enamel.
 - 2. Finish exceeds 250 hour salt spray test in accordance with ASTM B117.
 - 3. Color: As selected by Owner.
- E. Inside Casing:
 - 1. Galvanized Steel: Solid, 0.0276 inch thick.
- F. Floor Plate:
 - 1. Galvanized Steel: 0.0132 inch thick.
- G. Inspection Doors: 10 x 10 inch of galvanized steel for flush mounting, with gasket, latch, and handle assembly and 1/4 inch thick Plexiglas inspection window.
- H. Bottom Inlet Units: Furnish steel or aluminum walking grate on structural supports.
- I. Strength: Furnish structure to brace casings for suction pressure of 2.5 inch wg, with maximum deflection of 1 in 200.

2.3 FANS

- A. Type: Direct Drive plenum fans with integral frame motors on isolation bases. Dynamically balanced per AMCA 204.
- B. Performance Ratings: Conform to AMCA 210.
- C. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- D. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing.
- E. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Furnish access to motor, drive, and bearings through removable casing panels or hinged access doors. Mount base on vibration isolators.
- F. NEMA DOP or TEFC fan motors with motor shaft grounding rings.
- G. Fan Modulation: Variable Frequency Drive.
- H. Flexible Connection: Separate unit from connecting ductwork.

- I. Factory-provided automatic backdraft damper per fan.

2.4 COILS

- A. Casing with access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- C. Eliminators: Three break of galvanized steel, mounted over drain pan.
- D. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.
- E. Fabrication:
 - 1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
 - 2. Fins: Aluminum.
 - 3. Casing: Die formed channel frame of galvanized steel.
- F. Water Heating Coils:
 - 1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 - 2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.
- G. Provide extended drain and vent connections through casing on all water coils.
- H. Provide removable coil access panels on coil sections for ease of coil removal

2.5 FILTERS

- A. Filter Box: Section with filter guides, access doors from both sides, for side loading with gaskets and blank-off plates.
- B. Filter Media: UL 900 listed, Class I.
- C. Angle: 2 inches deep disposable panel filters.

2.6 ECONOMIZER

- A. Provide economizer components and controls in accordance with Current version of ICC IECC adopted by AHJ.
- B. Outside air intake shall be furnished with inlet hood and moisture eliminators
- C. Exhaust Air Hood shall come with bird screen to limit outdoor items from entering air handling unit

2.7 DAMPERS

- A. Mixing Boxes: Section with factory mounted outside and return air dampers of galvanized steel with vinyl bulb edging and edge seals in galvanized frame, with galvanized steel axles in self-lubricating brass bearings, in opposed blade arrangement with damper blades positioned across short air opening dimension. Furnish removable, full width support for freeze-protection thermostat, with removable end panel to permit support removal.

- B. Face and Bypass Dampers: Opposed blade, Airfoil style with compressible jamb seals and flexible blade-edge seals to allow airflow diversion around the coil. Damper actuator with feedback.
- C. Air Damper Leakage: Maximum 3.0 cfm per square foot at 1.0 inches wg pressure differential.
- D. Damper Leakage: Maximum 2 percent at 4 inch wg differential pressure when sized for 2000 fpm face velocity.
- E. Damper Actuators: Furnish factory installed electric damper actuators for outside air, return air, and exhaust air dampers.

2.8 CONTROLS

- A. Unit shall be provided with a factory wired, installed and tested unit controller, capable of standalone unit control and tied into a building automation system through BACnet MSTP communication.
- B. Furnish interface to Direct Digital Control System. The controls interface shall allow access by the Direct Digital Controls system to all internal points available within the unit that can be accessed by the unit manufacturer.
 - 1. Control Functions by Building Automation System (Provided by Temperature Controls Contractor, for reference only):
 - a. Unit scheduling.
 - b. Occupied-unoccupied mode.
 - c. Start-up and coast-down modes.
 - d. Nighttime free-cool purge mode.
 - e. Demand limiting.
 - f. Night setback.
 - g. Timed override.
 - h. Alarm shutdown.
 - i. Discharge air set point adjustment.
 - j. Static pressure setpoint adjustment.
 - 2. Furnish the following setpoints and diagnostic functions accessible in unit control panel (Manufacturer's controls):
 - a. Unit operating mode.
 - b. Unit failure status.
 - c. Supply fan start-stop.
 - d. Supply fan status.
 - e. Supply fan inlet guide vane position.
 - f. Supply fan variable frequency drive percent.
 - g. Supply air temperature.
 - h. Supply air temperature high-low limit with alarm.
 - i. Return air temperature.
 - j. Return air temperature high-low limit with alarm.
 - k. Mixed air temperature.
 - l. Mixed air temperature high-low limit with alarm.
 - m. Duct static pressure.
 - n. Duct static pressure high-low limit with alarm.
 - o. Heating control.
 - p. Heating status.
 - q. Heating Control valve status.
 - r. Heating Control Valve position.

- s. Damper control.
- t. Economizer status.
- u. Requested minimum position.
- v. Damper positions.
- w. Filter status.
- x. Smoke detector status.
- y. Outside air temperature.
- z. Outside relative humidity.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.2 INSTALLATION

- A. Install in accordance with ARI 430.
- B. Roof Curb:
 - 1. Assemble roof curb.
 - 2. Install roof curb level.
 - 3. Coordinate curb installation and flashing with roofing manufacturer.
 - 4. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
 - 5. Install gasket material between unit base and roof curb.
- C. Install flexible connections between unit and inlet and discharge ductwork. Install metal bands of connectors parallel with minimum 1 inch flex between ductwork and fan while running.
- D. Install assembled units with vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as [indicated] [required]. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- E. Provide adjustable sheaves required for final air balance.
- F. Insulate coil headers located outside airflow as specified for piping.
- G. Connect humidifiers to water supply. Install gate valve on water supply piping. Install 3/4 inch hose bibb accessible from interior. Pipe drain and overflow to nearest floor drain.

3.3 INSTALLATION HOT WATER HEATING COIL

- A. Make connections to coils with unions or flanges.
- B. Connect water supply to leaving airside of coil (counter flow arrangement).
- C. Locate water supply at bottom of supply header and return water connection at top.
- D. Install water coils to allow draining and install drain connection at low points.
- E. Install the following piping accessories on hot water piping connections.
 - 1. On supply:

- a. Thermometer well and thermometer.
 - b. Well for control system temperature sensor.
 - c. Shutoff valve.
 - d. Strainer.
 - e. Control valve.
 - f. Pressure gage.
2. On return:
- a. Thermometer well and thermometer.
 - b. Well for control system temperature sensor.
 - c. Pressure gage.
 - d. Shutoff valve.
 - e. Balancing valve.

F. Install manual air vents at high points complete with shutoff valve.

G. Install hot water piping accessories below roof.

3.4 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install new throwaway filters in units at Substantial Completion.

3.5 PROTECTION OF FINISHED WORK

A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

3.6 FIELD QUALITY CONTROL

A. Provide manufacturers factory start-up for all components.

B. Furnish services of manufacturer's technical representative for at least 8 hours in 2 separate visits to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days' notice to Owner of training date.

END OF SECTION

SECTION 23 81 06
PACKAGED ROOFTOP UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Packaged rooftop units.

1.2 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
1. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
 2. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
- B. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ASTM International:
1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 2. NEMA MG 1 - Motors and Generators.
- F. National Fire Protection Association:
1. NFPA 54 - National Fuel Gas Code.
 2. NFPA 58 - Liquefied Petroleum Gas Code.
 3. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 DEFINITIONS

- A. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.
- B. Integrated Part-Load Value (IPLV): Single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on basis of weighted operation at various load capacities for the equipment.

1.4 SUBMITTALS

- A. Product Data: Submit data indicating:
1. Cooling and heating capacities.
 2. Dimensions.
 3. Weights.

4. Rough-in connections and connection requirements.
5. Duct connections.
6. Electrical requirements with electrical characteristics and connection requirements.
7. Controls.
8. Accessories.

- B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of controls installed remotely from units.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.6 QUALITY ASSURANCE

- A. Sound Rating: Measure in accordance with ARI 270.
- B. Insulation and adhesives: Meet requirements of NFPA 90A.
- C. Minimum heating efficiency: 80 percent.
- D. Performance Requirements: Conform to minimum EER prescribed by ASHRAE 90.1 when tested in accordance with ARI 340/360.
- E. Outside Air Damper Leakage: Test in accordance with AMCA 500.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept units on site. Inspect for damage.
- B. Protect units from damage by storing off roof until roof mounting curbs are in place.

1.8 COORDINATION

- A. Coordinate installation of roof curbs with roof structure, roof deck and roof membrane installation.

PART 2 PRODUCTS

2.1 ROOFTOP UNIT

- A. Manufacturers:
 1. Daikin Industries
 2. Aeon Incorporated
 3. The Trane Company
- B. Product Description: Self-contained, packaged, factory assembled and wired, consisting of roof curb, supply and return plenum, cabinet, supply fan, inlet guide vanes, variable frequency drive, evaporator coil, compressor, refrigeration circuit, condenser, gas burners, air filters, outdoor air section, exhaust fan, and controls.

- C. Compliant with ASHRAE 90.1-2015.
- D. Configuration: Downflow air delivery.
- E. Mounting Curb:
 - 1. Minimum 12 inch high, galvanized steel, channel frame with gaskets, nailer strips. Full perimeter curb under entire unit, with gasket strip.
 - 2. Designed to meet the seismic/wind load rating per IBC 2017 Chapter 15.
- F. Cabinet:
 - 1. Designed for outdoor installation with weatherproof construction.
 - 2. Panels: Double wall, Galvanized steel with corrosion resistant baked enamel finish meeting 750 hour salt spray test in accordance with ASTM B117. Furnish hinged access doors with handles and rubber gaskets at edges.
 - 3. Insulation: Factory applied to exposed vertical panels, horizontal panels, and access doors. 2 inch thick, 1.5 pound per cubic foot density, R-13, protected from erosion or sandwich panels with injected foam.
- G. Supply Fan:
 - 1. Fan: Airfoil type, statically and dynamically balanced, resiliently mounted.
 - 2. Fan Drive: Direct or V-Belt type, Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Furnish solid shaft construction. Select Variable and adjustable pitch motor sheave to obtain required rpm with sheaves set at mid-position as recommended by manufacturer.
 - a. Drive Rating: Minimum 1.5 times nameplate rating of motor.
 - b. Steel shaft.
 - c. Bearings with L-50 life at 250,000.
 - 3. Fan motor: Three phase, NEMA MG1, Design B, continuously rated at 40 degrees C, open drip-proof NEMA T frame, with permanently lubricated bearings and integral overload protection.
 - 4. Fan Assembly Mounting: Furnish spring-type vibration isolators.
- H. Supply Fan Modulation:
 - 1. Variable Frequency Drive:
 - a. Furnished for supply fan and return fan.
 - b. Factory installed, wired, and tested.
 - c. Full digital control.
 - d. Insulated Gate Bi-Polar Transistors used to produce output pulse width modulation waveform allowing quiet operation.
 - e. NEMA 250 Type 1 enclosure.
 - f. Self-diagnostics.
 - g. Proportional-integral-derivative setpoint control.
 - h. Communication port.
 - i. Electronic thermal overload protection.
 - 2. Controlled from duct static pressure by unit mounted controller. Static pressure sensed by duct mounted sensor.
 - 3. Furnish field adjustable duct high limit safety control to protect duct work from excessive duct pressure.
- I. Evaporator Coil:
 - 1. Constructed of seamless copper tubes mechanically expanded into aluminum fins. Factory leak tested under water.
 - 2. Stainless Steel drain pan and piping connection.
 - 3. Furnish for multiple circuited units intertwined row circuiting.
- J. Compressors:

1. Hermetically sealed, resiliently mounted with positive lubrication, inverter type, and internal motor overload protection.
 2. Factory charged with R-401A.
 3. Independent refrigeration cycle for each compressor.
 4. Furnish internal vibration isolators.
 5. Furnish short cycle protection.
 6. Crank cast heater, sight glass, anti-slug protection, time delay to avoid short cycling.
- K. Refrigeration circuit:
1. Dehydrate and factory charge each circuit with oil and refrigerant.
 2. Furnish the following for each circuit:
 - a. Thermostatic expansion device.
 - b. Filter-drier.
 - c. Suction, discharge, and liquid line service valves with gauge ports.
 - d. Sight glass.
 - e. High and low pressure safety controls.
 3. Furnish capacity control by cycling multi-speed compressors.
- L. Condenser:
1. Constructed of copper tubing mechanically bonded to aluminum fins. Factory leak tested under water.
 2. Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Motor permanently lubricated with built-in thermal overload protection.
 3. Furnish factory installed coil guard.
 4. Furnish coil with corrosion resistant coating capable of withstanding salt spray test of 1000 hours in accordance with ASTM B117.
- M. Air Filters: 2 inch thick glass fiber, MERV 8 disposable media in metal frames.
- N. Outdoor Air Section:
1. Economizer: Provide economizer components and controls in accordance with ICC IECC. Furnish fully integrated factory installed fully modulating from 0 to 100 percent outside air economizer. Economizer operation through microprocessor based primary temperature controls automatically modulate dampers to maintain space temperature and occupancy conditions.
 - a. Outdoor air hood.
 - b. Furnish with outdoor, return and exhaust air dampers sized for full economizer mode.
 - 1) Gasketed design with air leakage rate of less than 1.5 cfm/sq. ft, AMCA 500.
 - 2) Bird Screen on outdoor and exhaust air dampers.
 - 3) Factory installed modulating control damper actuators with spring return.
 - c. Furnish economizer with dry bulb control.
 - d. Furnish adjustable minimum position control located remotely in space.
 - e. Furnish spring return motor for outside air damper closure during unit shutdown or power interruption.
 - f. Provide with factory On/Off powered exhaust
 - g. Outside air compensation shall control outside air damper position depending on fan speed.
- O. Gas Heat Section:
1. Heat Exchanger: Tubular stainless steel heat exchanger with in-shot burner manifold.
 2. Natural gas burner with electric ignition
 3. Induced draft blower fan.
 4. Modulating burner control with roll-out safety protection, with a minimum 4:1 modulation capability.
 5. Factory installed unit control system to allow gas heat module.
- P. Controls:

1. Variable Air Volume Controls: To operate VAV rooftop from supply air temperature including supply air sensor, and variable frequency drive. Microprocessor coordinates economizer control and stages of cooling.
2. Furnish interface to Direct Digital Control System. The unit shall be complete with BACnet communication interface that allows direct connection to the existing controls network. The controls interface shall allow access by the Direct Digital Controls system to all internal points available within the unit that can be accessed by the unit manufacturer.
3. Control Functions by Building Automation System (Provided by Temperature Controls Contractor, for reference only):
 - a. Unit scheduling.
 - b. Occupied-unoccupied mode.
 - c. Start-up and coast-down modes.
 - d. Nighttime free-cool purge mode.
 - e. Demand limiting.
 - f. Night setback.
 - g. Timed override.
 - h. Alarm shutdown.
 - i. Discharge air set point adjustment.
 - j. Static pressure setpoint adjustment.
4. Furnish the following setpoints and diagnostic functions accessible in unit control panel (Manufacturer's controls):
 - a. Unit operating mode.
 - b. Unit failure status.
 - c. Supply fan start-stop.
 - d. Supply fan status.
 - e. Supply fan inlet guide vane position.
 - f. Supply fan variable frequency drive percent.
 - g. Supply air temperature.
 - h. Supply air temperature high-low limit with alarm.
 - i. Return air temperature.
 - j. Return air temperature high-low limit with alarm.
 - k. Mixed air temperature.
 - l. Mixed air temperature high-low limit with alarm.
 - m. Duct static pressure.
 - n. Duct static pressure high-low limit with alarm.
 - o. Cooling control.
 - p. Cooling status - all stages.
 - q. Heating control.
 - r. Heating status.
 - s. Number of stages activated.
 - t. Damper control.
 - u. Economizer status.
 - v. Requested minimum position.
 - w. Damper positions.
 - x. Filter status.
 - y. Smoke detector status.
 - z. Outside air temperature.
 - aa. Outside relative humidity.
5. Ventilation Override: Factory installed. Binary input from independent fire or life safety panel causes unit to override standard operation and assumes one of two factory preset ventilation sequences - purge or pressurization.

Q. Accessories:

1. Convenience Outlet: Factory installed, 115 volt, 15 amp, GFI type, internally mounted. Factory wired from transformer internal to unit.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 INSTALLATION

- A. Curb:
 1. Assemble curb.
 2. Install curb level.
 3. Coordinate curb installation and flashing.
 4. Install units on curb providing watertight enclosure to protect ductwork and utility services.
 5. Install gasket material between unit base and curb.
- B. Install units on vibration isolators.
- C. Connect units to supply and return ductwork with flexible connections.
- D. Install condensate piping with trap and route from drain pan to nearest roof drain.
- E. Install components furnished loose for field mounting.
- F. Install electrical devices furnished loose for field mounting.
- G. Install control wiring between unit and field installed accessories.
- H. Remove from roof and dispose off-site panels removed from units during installation of economizer.
- I. Provide sheaves required for final air balance.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Furnish services of factory trained representative for minimum of two days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.
- B. Start-up units according to manufacturer's start-up instructions and in presence of unit manufacturer's representative, general contractor, sub-contractor, engineer and owner. Test controls and demonstrate compliance with requirements. Adjust burners for maximum efficiency. Replace damaged or malfunctioning controls and equipment.
- C. Provide services of factory trained representative for two years after final acceptance of the unit.

3.4 CLEANING

- A. Vacuum clean coils and inside of cabinets.

- B. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.5 FIELD QUALITY CONTROL

- A. Provide manufacturers factory start-up for all components.
- B. Furnish services of manufacturer's technical representative for at least 8 hours in 2 separate visits to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days' notice to Owner of training date.

END OF SECTION

SECTION 23 81 07

PACKAGED ROOFTOP UNITS - MEDIUM CAPACITY

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Packaged rooftop unit.
 - 2. Roof curb.

1.2 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
 - 2. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ASTM International:
 - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA MG 1 - Motors and Generators.

1.3 SUBMITTALS

- A. Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections.
- B. Submit product data indicating rated capacities, weights, accessories, service clearances, acoustical performance and electrical requirements.
- C. Submit manufacturer's installation instructions.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, start-up and operating instructions, installation instructions, and maintenance procedures.

1.5 HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.6 QUALITY ASSURANCE

- A. Unit shall be rated in accordance with AHRI Standard 340/360, latest edition.
- B. Unit shall be designed to conform to ANSI/ASHRAE 15 (latest edition), ASHRAE 62, and UL Standard 1995.
- C. Unit shall be listed by ETL and ETL, Canada as a total package.
- D. 48A3, A5 units shall be designed to conform with ANSI Standard Z21.47.
- E. Roof curb shall be designed to NRCA criteria per Bulletin B-1986.
- F. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
- G. Unit shall be manufactured in a facility registered to the ISO 9001 manufacturing quality standard.

1.7 WARRANTY

- A. Furnish five year manufacturer's parts and refrigerant warranty for compressors.
- B. Provide a one year parts warranty on the entire unit.

1.8 EXTRA MATERIALS

- A. Provide one set of construction throwaway filters and two sets of final filters.

1.9 SUMMARY

- A. The contractor shall furnish and install packaged rooftop air conditioning unit(s) as shown and as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the conditions specified, scheduled or as shown on the contract drawings.

PART 2 PRODUCTS

2.1 PACKAGED ROOFTOP AIR CONDITIONING UNITS

A. Manufacturers:

- 1. The Trane Company
- 2. Daikin Industries.
- 3. Aeon Incorporated.

B. General Description:

- 1. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, gas heaters, modulating exhaust fans, and unit controls.
- 2. Unit shall be factory assembled and tested including leak testing of the DX coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
- 3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- 4. Unit components shall be labeled, including refrigeration system components and electrical and controls components.
- 5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
- 6. Installation, Operation, and Maintenance manual shall be supplied within the unit.
- 7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
- 8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

C. Construction:

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of R8. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
4. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
5. Access to filters, dampers, cooling coils, hot water coils, supply fans, exhaust fans, variable frequency drives, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
6. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
7. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
8. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
9. Unit shall include lifting lugs on the top of the unit.
10. Unit shall include factory installed, painted galvanized steel condenser coil guards on the face of the condenser coil.

D. Electrical:

1. Unit shall be provided with factory installed terminal block. Unit shall be dual point power, with field installed disconnects per circuit.
2. Provide Unit Interrupt Rating (Short Circuit Current Rating-SCCR). A 5,000 Amp rating shall be applied to the unit enclosure using a non-fused circuit breaker for disconnect switch purposes. Fan motors, compressors, and electric heat circuits shall be provided with series rated circuit breakers that will provide the unit rated level of protection. The unit shall be marked with approved cULus markings and will adhere to cULus regulations

E. Supply Fans:

1. Unit shall include Dual direct drive, unhooded, backward curved, plenum supply fans
2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
3. Entire assembly shall be completely isolated from unit and fan board by 2 in deflection spring isolation
4. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
5. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
6. Each Direct Drive Fan shall have its own VFD, and sized for 100% Redundancy for continuous operation, if one fan motor goes down.

F. Exhaust Fans:

1. Exhaust dampers shall be sized for 100% relief.
2. Fans and motors shall be dynamically balanced.
3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
5. Unit shall include belt driven, unhooded, backward curved, plenum exhaust fans.
6. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
7. Provide all of the specifications above as well as direct space sensing building pressurization control. The (Statitrac) control system shall modulate the Exhaust fan VFD or discharge dampers to control the

building pressure to within the adjustable, specified deadband that shall be adjustable at the Human Interface Panel.

G. Outdoor Air Section:

1. Provide 0-100 Percent Modulating Economizer. Shall be operated through the primary temperature controls to automatically utilize OA for "free" cooling. Automatically modulated RA and OA dampers shall maintain proper temperature in the space. Economizer shall be equipped with an automatic lock out when the outdoor high ambient temperature is too high for proper cooling. Minimum position control shall be standard and adjustable at the Human Interface Panel or with a remote potentiometer or through the building management system. A spring return motor shall ensure closure of OA dampers during unit shutdown or power interruption. Mechanical cooling shall be available to aid the economizer mode at any ambient. Control shall be through Dry Bulb.
2. Provide Outside Air Measurement. A factory mounted airflow measurement station (Traq) shall be provided in the outside air opening to measure airflow. The airflow measurement station shall measure from 15 to 100 percent of unit airflow. The airflow measurement station shall adjust for temperature variations

H. Cooling Coils:

1. Evaporator Coils:

- a. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
- b. Coils shall have interlaced circuitry and shall be minimum 6 row
- c. Coils shall be hydrogen or helium leak tested.
- d. Coils shall be furnished with factory installed expansion valves.

I. Refrigeration System:

1. Unit shall be factory charged with R-410A refrigerant.
2. Compressors shall be variable capacity, scroll type with thermal overload protection and carry a 5-year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides and a factory installed replaceable core liquid line filter driers.
7. Unit shall include multistage scroll compressors

J. Condensers:

1. Air-Cooled Condenser:

- a. Condenser fans shall be a vertical discharge, axial flow, direct drive fans.
- b. Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
- c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
- d. Coils shall be hydrogen or helium leak tested.
- e. Provide condenser coil guards.

K. Hot Water Coil

1. Casing with access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

2. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
3. Eliminators: Three break of galvanized steel, mounted over drain pan.
4. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.
5. Fabrication:
 - a. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
 - b. Fins: Aluminum.
 - c. Casing: Die formed channel frame of galvanized steel.
6. Water Heating Coils:
 - a. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 - b. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

L. Filters:

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the cooling coil.
2. Unit shall be capable of 0-100% economizer consisting of a motor DDC operated low leakage outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Provide Ultra Low Leak Dampers. Dampers shall be AMCA 511 Class 1A certified with a maximum leakage rate of 3 cfm/sq-ft at 1.0 in WC pressure differential thus exceeding requirements of ASHRAE 90.1-2013, California Title 24-2013, and IECC-2012 Damper assembly shall be controlled by spring return enthalpy activated fully modulating actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.
3. Economizer shall be furnished with return air CO2 override.
4. Provide 0-100 Percent Modulating Economizer. Shall be operated through the primary temperature controls to automatically utilize OA for "free" cooling. Automatically modulated RA and OA dampers shall maintain proper temperature in the space. Economizer shall be equipped with an automatic lock out when the outdoor high ambient temperature is too high for proper cooling. Minimum position control shall be standard and adjustable at the Human Interface Panel or with a remote potentiometer or through the building management system. A spring return motor shall ensure closure of OA dampers during unit shutdown or power interruption. Mechanical cooling shall be available to aid the economizer mode at any ambient. Control shall be through comparative enthalpy.

M. Controls:

1. Furnish interface to Direct Digital Control System. The unit shall be complete with BACnet communication interface that allows direct connection to the existing controls network. The controls interface shall allow access by the Direct Digital Controls system to all internal points available within the unit that can be accessed by the unit manufacturer.
2. Control Functions by Building Automation System (Provided by Temperature Controls Contractor, for reference only):
 - a. Unit scheduling.
 - b. Occupied-unoccupied mode.
 - c. Start-up and coast-down modes.
 - d. Nighttime free-cool purge mode.
 - e. Demand limiting.
 - f. Night setback.
 - g. Timed override.
 - h. Alarm shutdown.
 - i. Discharge air set point adjustment.
 - j. Static pressure setpoint adjustment.
3. Furnish the following setpoints and diagnostic functions accessible in unit control panel (Manufacturer's controls):
 - a. Unit operating mode.
 - b. Unit failure status.
 - c. Supply fan start-stop.

- d. Supply fan status.
- e. Supply fan inlet guide vane position.
- f. Supply fan variable frequency drive percent.
- g. Supply air temperature.
- h. Supply air temperature high-low limit with alarm.
- i. Return air temperature.
- j. Return air temperature high-low limit with alarm.
- k. Mixed air temperature.
- l. Mixed air temperature high-low limit with alarm.
- m. Duct static pressure.
- n. Duct static pressure high-low limit with alarm.
- o. Cooling control.
- p. Cooling status - all stages.
- q. Heating control.
- r. Heating status.
- s. Heating Control valve status.
- t. Heating Control Valve position.
- u. Damper control.
- v. Economizer status.
- w. Requested minimum position.
- x. Damper positions.
- y. Filter status.
- z. Smoke detector status.
- aa. Outside air temperature.
- bb. Outside relative humidity.

N. Roof Curbs

1. Manufacturer's insulated, solid bottom roof curb including pipe passage for hot water supply/return piping to unit mounted coil. Curb to be minimum 18" above high point of roof insulation/membrane. Infill space between top of roof and bottom of unit with drywall and sound batt insulation. Refer to detail on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as recommended by manufacturer.
- B. Contractor shall verify that the proper power supply has been provided.

3.2 INSTALLATION

- A. Roof Curb:
 1. Install roof curb level.
 2. Infill space between top of roof and bottom of unit with drywall and sound batt insulation. Refer to detail on drawings.
 3. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
 4. Install gasket material between unit base and roof curb.
- B. Connect units to supply and return ductwork with flexible connections.
- C. Install components furnished loose for field mounting.
- D. Install electrical devices furnished loose for field mounting.
- E. Install control wiring between unit and field installed accessories.
- F. Remove from roof and dispose off-site panels removed from units during installation of all accessories.

G. Install in accordance with the manufacturer's installation manual.

3.3 INSTALLATION – HOT WATER COIL

A. Connect new unit mounted hot water coil to existing HWS/R piping and new/replacement hot water coil per installation details shown on drawings.

3.4 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install new throwaway filters in units at Substantial Completion.

C. Install temporary filters during construction period. Replace with final filters at Substantial Completion.

3.5 MANUFACTURER'S FIELD SERVICES

A. Manufacturer shall furnish a factory trained service engineer without additional charge to start the units. Package rooftop unitary manufacturers shall maintain service capabilities no more than 100 miles from the jobsite.

B. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

C. Furnish services of manufacturer's technical representative for one half day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner. All training shall be videotaped by the owner.

END OF SECTION

SECTION 23 81 26

DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Indoor Evaporator unit.
 2. Outdoor Condensing unit.

1.2 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
 3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
 4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASTM International:
1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- D. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.
- E. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

- A. Product Data: Submit data indicating:
1. Cooling and heating capacities.
 2. Dimensions.
 3. Weights.
 4. Rough-in connections and connection requirements.
 5. Duct connections.
 6. Electrical requirements with electrical characteristics and connection requirements.
 7. Controls.
 8. Accessories.
- B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

- A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI.
- B. Sound Rating: Measure in accordance with ARI 270.
- C. Insulation and adhesives: Meet requirements of NFPA 90A.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.7 COORDINATION

- A. Coordinate installation of condensing units with concrete pad or shelves, as specified.
- B. Coordinate installation of air handling units with building structure.

PART 2 PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS (55-DSS-1, 61-DSS-1, 79-DSS-1)

- A. Manufacturers:
 - 1. Toshiba/Carrier
 - 2. Mitsubishi
 - 3. Trane
 - 4. Daikin
- B. Product Description: Split system consisting of air handling unit and condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

2.2 INDOOR UNIT

- A. Indoor, direct-expansion, ceiling-mounted fan coil. Unit shall be complete with cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing.
- B. Cabinet shall be fully insulated for improved thermal and acoustic performance.
- C. Fan shall be tangential direct-drive blower type with air intake at the rear or bottom of the unit and discharge at the front.
- D. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a factory installed condensate pump and drain connection for hose attachment to remove condensate.

- E. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
- F. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 62 °F to 86 °F (17 °C to 30 °C) in increments of 1 °F or 1 °C, and have 46 °F Heating Mode (Heating Setback).
- G. The units shall have the following functions as a minimum:
 1. An automatic restart after power failure at the same operating conditions as at failure.
 2. A timer function to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
 3. Temperature-sensing controls shall sense return air temperature.
 4. Indoor coil freeze protection.
 5. Wireless infrared remote control and/or wired remote control to enter set points and operating conditions.
 6. Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.
 7. Fan-only operation to provide room air circulation when no cooling is required.
 8. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.
 9. Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.
 10. Automatic heating-to-cooling changeover in heat pump mode. Control shall include deadband to prevent rapid mode cycling between heating and cooling.
 11. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.

2.3 OUTDOOR UNIT

- A. General: Factory assembled and tested air-cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.
- B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.
- C. Compressor: Single refrigeration circuit with rotary or hermetic type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.
- D. Condenser Coil: Constructed of copper tubing mechanically bonded to aluminum fins, factory leak and pressure tested.
- E. Controls: Furnish operating and safety controls including high- and low-pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.
- F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.
- G. Condensing Unit Accessories: Furnish the following accessories:
 1. Controls to provide low ambient heating/cooling to -20 degrees F.
 2. Time delay relay.
 3. Anti-short cycle timer.
 4. Vibration isolators.
 5. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.

6. Suction and discharge pressure gauges.
- H. Refrigeration specialties: Furnish the following:
1. Charge of compressor oil.
 2. Holding charge of refrigerant.
 3. Replaceable core type filter drier.
 4. Liquid line sight glass and moisture indicator.
 5. Shut-off valves on suction and liquid piping.
 6. Liquid line solenoid valve.
 7. Charging valve.
 8. Oil level sight glass.
 9. Crankcase heater.
 10. Pressure relief device.
- I. Refrigerant: Furnish charge of refrigerant R-410a.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify concrete pad for condensing unit is ready for unit installation.

3.2 INSTALLATION - INDOOR UNIT

- A. Install condensate piping with trap and route from drain pan to condensate drainage system.
- B. Install components furnished loose for field mounting.

3.3 INSTALLATION - CONDENSING UNIT

- A. Install units on manufacturer's wall brackets.
- B. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit.
- C. Evacuate refrigerant piping and install initial charge of refrigerant.
- D. Install electrical devices furnished loose for field mounting.
- E. Install control wiring between air handling unit, condensing unit, and field installed accessories.

3.4 CLEANING

- A. Vacuum clean coils and inside of unit cabinet.
- B. Install new cleanable filters in units at Substantial Completion.

3.5 PROTECTION OF FINISHED WORK

- A. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

3.6 THERMOSTATS

- A. Mount all thermostats and switches at the same elevation as the room light switches.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SUMMARY

- A. The electrical work included in all other divisions is the responsibility of the contractor performing the Division 26 work unless noted otherwise.
- B. SCOPE
1. The work under this section includes basic electrical requirements, which are applicable to all Division 26 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:
 - a. PART 1 - GENERAL
 - 1) Project Overview
 - 2) Scope
 - 3) Related Work
 - 4) Reference Standards
 - 5) Regulatory Requirements
 - 6) Quality Assurance
 - 7) Continuity of Existing Services and Systems
 - 8) Approved Electrical Testing Laboratories
 - 9) Sealing and Fire Stopping
 - 10) Intent
 - 11) Omissions
 - 12) Work Sequence and Scheduling
 - 13) Salvage Materials
 - 14) Certificates and Inspections
 - b. PART 2 - PRODUCTS
 - 1) Access Panels and Doors
 - c. PART 3 - EXECUTION
 - 1) Excavation and Backfill
 - 2) Concrete Work
 - 3) Equipment Access
 - 4) Coordination
 - 5) Housekeeping and Clean Up

1.2 REFERENCES

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:
1. ANSI American National Standards Institute
 2. ASTM American Society for Testing and Materials
 3. EPA Environmental Protection Agency
 4. ETL Electrical Testing Laboratories, Inc.
 5. IEEE Institute of Electrical and Electronics Engineers
 6. IES Illuminating Engineering Society
 7. ISA Instrument Society of America
 8. NBS National Bureau of Standards
 9. NEC National Electric Code
 10. NEMA National Electrical Manufacturers Association
 11. NESC National Electrical Safety Code

- 12. NFPA National Fire Protection Association
- 13. UL Underwriters Laboratories Inc.

1.3 REGULATORY REQUIREMENTS

- A. All work and materials are to conform in every detail to applicable rules and requirements of the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

1.4 QUALITY ASSURANCE

- A. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space, and for obtaining the performance from the system into which these items are placed.
- B. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.
- C. All materials, except medium voltage equipment and components, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, except for medium voltage equipment and components, shall be so labeled.

1.5 CONTINUITY OF EXISTING SERVICE AND SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the Owner. Any outage must be scheduled when the interruption causes the least interference with normal institutional schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.
- B. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible. Note that operations are on a seven-day week schedule.

1.6 APPROVED ELECTRICAL TESTING LABORATORIES

- A. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
 - 1. Underwriters Laboratories Inc.
 - 2. Electrical Testing Laboratories, Inc.

1.7 SEALING AND FIRESTOPPING

- A. Sealing and fire stopping of sleeves/openings between conduits, cable trays, wireways, troughs, cablebus, busduct, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 13 Penetration Firestopping.

1.8 INTENT

- A. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
- B. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits the intent (as determined by the Engineer). Refer to the General Conditions of the Contract for further clarification.
- C. It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- D. All sizes as given are minimum except as noted.
- E. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the A/E's inspections, tests and approval from the commencement until the acceptance of the completed work.
- F. Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply

1.9 OMISSIONS

- A. No later than ten (10) days before bid opening, the Contractor shall call the attention of the Engineer to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted

1.10 WORK SEQUENCE AND SCHEDULING

- A. Install work in phases to accommodate Owner's requirements. During the construction period coordinate electrical schedule and operations with General Contractor.

1.11 SALVAGED MATERIALS

- A. No materials removed from this project shall be reused except as noted on the Drawings. All materials removed shall become the property of and shall be disposed of by the Contractor.

1.12 CERTIFICATES AND INSPECTIONS

- A. Obtain and pay for all required installation inspections. Deliver originals of these certificates to the Owner.

PART 2 PRODUCTS

2.1 ACCESS DOORS AND PANELS

- A. Lay-in Ceilings:
 - 1. Removable lay-in ceiling tiles in 2 x 2 foot or 2 x 4 foot configuration provided under other divisions are sufficient; no additional access provisions are required unless specifically indicated.

- B. Plaster Walls and Ceilings:
 - 1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers and similar wet areas, concealed hinges, screwdriver operated cam latch for general application, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

- A. Not used.

3.2 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish the access doors to the General Contractor and reimburse the General Contractor for installation of those access door.

3.3 COORDINATION

- A. The Contractor shall cooperate with other trades and the Owner in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.
- B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.
- C. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.
- D. Verify the integrity of any fire or smoke rating on these surfaces.

3.4 HOUSEKEEPING AND CLEAN UP

- A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

END OF SECTION

SECTION 26 05 02

ELECTRICAL DEMOLITION FOR REMODELING

PART 1 GENERAL

1.1 SUMMARY

- A. The work under this section includes disconnection of existing electrical equipment as required for equipment replacement.

1.2 RELATED WORK

- A. Applicable provisions of Division 01 govern work under this section.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work as specified in the individual Sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Demolition Drawings are based on casual field observation and/or existing record documents. Report discrepancies to the Architect/Engineer before disturbing existing installation.
- C. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with the Owner, General Contractor, and Architect/Engineer. Also, coordinate utility service outages with the local Utility Company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations and follow the safe working practice requirements of NFPA 70E.

END OF SECTION

SECTION 26 05 03
EQUIPMENT WIRING CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes electrical connections to equipment.
- B. Related Sections:
 - 1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

- A. None Required.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Submittal procedures.
- B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.5 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- E. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 CORD AND PLUGS

- A. Manufacturers:
 - 1. Legrand North America, LLC (Pass and Seymour).
 - 2. Leviton Manufacturing Co., Inc.
- B. Attachment Plug Construction: Conform to NEMA WD 1.

- C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.
- D. Cord Construction: Oil-resistant thermoset insulated multi-conductor flexible cord with identified equipment grounding conductor, suitable for usage in damp locations.
- E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 EXISTING WORK

- A. Remove exposed abandoned equipment wiring connections, including abandoned connections above accessible ceiling finishes.
- B. Disconnect abandoned utilization equipment and remove wiring connections. Remove abandoned components when connected raceway is abandoned and removed. Install blank cover for abandoned boxes and enclosures not removed.
- C. Extend existing equipment connections using materials and methods as specified.

3.3 INSTALLATION

- A. Make electrical connections.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Install receptacle outlet to accommodate connection with attachment plug.
- E. Install cord and cap for field-supplied attachment plug.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

3.5 EQUIPMENT CONNECTION SCHEDULE

- A. See Drawings.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes building wire and cable, wiring connectors and connections.
- B. Related Sections:
 - 1. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.

1.2 REFERENCES

- A. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- C. Underwriters Laboratories, Inc.:
 - 1. UL 1277 - Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 - 1. Stranded conductor for feeders and branch circuits 10 AWG and smaller.
 - 2. Stranded conductors for control circuits.
 - 3. Conductor not smaller than 12 AWG for power and lighting circuits.
 - 4. Conductor not smaller than 14 AWG for control circuits.
 - 5. Increase wire size in branch circuits to limit voltage drop to a maximum of 3 percent.
- B. Wiring Methods: Provide the following wiring methods:
 - 1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation in raceway.
 - 2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation in raceway.
 - 3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation in raceway.
 - 4. Wet or Damp Interior Locations: Use only building wire, Type XHHW insulation in raceway.
 - 5. Exterior Locations: Use only building wire, Type XHHW insulation in raceway.
 - 6. Underground Locations: Use only building wire, Type XHHW insulation in raceway.

1.4 DESIGN REQUIREMENTS

- A. Conductor sizes are based on copper.

1.5 SUBMITTALS

- A. Product Data: Submit for building wire.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of components and circuits.

1.7 QUALITY ASSURANCE

- A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements are as indicated on Drawings.

1.10 COORDINATION

- A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.
- B. Wire and cable routing indicated is approximate unless dimensioned.

PART 2 PRODUCTS

2.1 BUILDING WIRE

- A. Manufacturers:
 - 1. Southwire Company.
 - 2. General Cable.
 - 3. Approved Equal.
- B. Product Description: Single conductor insulated wire.
- C. Conductor: Copper.
- D. Insulation Voltage Rating: 600 volts.
- E. Insulation Temperature Rating: 90 degrees C.

2.2 WIRING CONNECTORS

- A. Manufacturers; Insulated Mechanical Lugs:
 - 1. NSI Polaris.
 - 2. IlSCO.
 - 3. Approved Equal.
- B. Manufacturers; Solderless Pressure Connectors:
 - 1. 3M.

2. Ideal Industries.
3. Approved Equal.

C. Manufacturers; Spring Wire Connectors:

1. 3M.
2. Ideal Industries.
3. Approved Equal.

D. Manufacturers; Compression Connectors:

1. Burndy.
2. Ideal Industries.
3. Approved Equal.

2.3 TERMINATIONS

- A. Terminal Lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.
- B. Lugs for Wires 4 AWG and Larger: Color keyed, compression type copper, with insulating sealing collars.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify interior of building has been protected from weather.
- B. Verify mechanical work likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3 EXISTING WORK

- A. Remove exposed abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.
- D. Extend existing circuits using materials and methods as specified.
- E. Clean and repair existing wire and cable remaining or wire and cable to be reinstalled.

3.4 INSTALLATION

- A. Route wire and cable to meet Project conditions.

- B. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- C. Identify wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
- D. Special Techniques--Building Wire in Raceway:
 - 1. Pull conductors into raceway at same time.
 - 2. Install building wire 4 AWG and larger with pulling equipment.
- E. Special Techniques - Wiring Connections:
 - 1. Clean conductor surfaces before installing lugs and connectors.
 - 2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 - 3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
 - 4. Install insulated mechanical lugs for copper conductor splices and taps, 6 AWG and larger.
 - 5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 - 6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- F. Install stranded conductors for branch circuits 10 AWG and smaller. Install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.
- G. Install terminal lugs on ends of 600-volt wires unless lugs are furnished on connected device, such as circuit breakers.
- H. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.
- I. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

3.5 WIRE COLOR

- A. General:
 - 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase.
- E. Ground Conductors:
 - 1. For 6 AWG and smaller: Green.
 - 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.6 FIELD QUALITY CONTROL

- A. Visually inspect conductors, lugs, connectors and all other components for physical damage and proper connections.
- B. Check all conductor connectors for tightness (with a torque wrench) and clearances. Torque test conductor terminations to manufacturer's recommendations.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rod electrodes.
 - 2. Wire.
 - 3. Mechanical connectors.
 - 4. Exothermic connections.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 99 - Standard for Health Care Facilities.

1.3 SYSTEM DESCRIPTION

- A. Grounding systems use the following elements as grounding electrodes:
 - 1. Existing Metal underground water pipe.
 - 2. Metal building frame.
 - 3. Concrete-encased electrode.
 - 4. Rod electrode.

1.4 DESIGN REQUIREMENTS

- A. Not Used.

1.5 PERFORMANCE REQUIREMENTS

- A. Not Used.

1.6 SUBMITTALS

- A. Product Data: Submit data on grounding electrodes and connections.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of components and grounding electrodes.

1.8 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.10 PRE-INSTALLATION MEETINGS

- A. None Required.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.12 COORDINATION

- A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

- A. Manufacturers:
 - 1. Erico.
 - 2. Harger Lightning and Grounding.
 - 3. Approved Equal.
- B. Product Description:
 - 1. Material: Copper-clad steel.
 - 2. Diameter: 3/4-inch.
 - 3. Length: 10 feet.
- C. Connector: Connector for exothermic welded connection.

2.2 WIRE

- A. Material: Stranded copper.
- B. Grounding Electrode Conductor: Copper conductor bare.
- C. Bonding Conductor: Copper conductor bare.

2.3 MECHANICAL CONNECTORS

- A. Manufacturers:
 - 1. Burndy.
 - 2. Erico.
 - 3. Approved Equal.
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. Burndy.
 - 2. Erico.
 - 3. Approved Equal.
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

- A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.3 EXISTING WORK

- A. Remove all accessible existing conductors and connections associated with the existing grounding electrode system after the existing electrical service is de-energized and removed.

3.4 INSTALLATION

- A. Install rod electrodes at locations as indicated on Drawings.
- B. Install grounding and bonding conductors concealed from view.
- C. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- D. Install continuous grounding using underground cold-water system and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
- E. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
- F. Install branch circuits feeding isolated ground receptacles with separate insulated grounding conductor, connected only at isolated ground receptacle, ground terminals, and at ground bus of serving panel.
- G. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.
- H. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.5 FIELD QUALITY CONTROL

- A. Inspect the ground system for adequate termination at all devices.
- B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- C. Perform fall-of-potential ground resistance test. Provide test results for review to the engineer.
- D. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Firestopping relating to electrical work.
 - 7. Firestopping accessories.
 - 8. Equipment bases and supports.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- B. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved by Factory Mutual Research for Property Conservation.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
- D. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.
- E. Intertek Testing Services (Warnock Hersey Listed):
 - 1. WH - Certification Listings.

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, or UL 1479 to achieve fire ratings of adjacent construction.
- B. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.6 SUBMITTALS

- A. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- B. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10-inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10-inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.9 PRE-INSTALLATION MEETINGS

- A. None Required.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Thomas and Betts Corporation.
 - 2. Unistrut.
 - 3. Approved Equal.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One-hole malleable iron for surface mounted conduits.

2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. B-Line.
 - 2. Unistrut.
 - 3. Approved Equal.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

- A. Manufacturers:
 1. B-Line.
 2. Minerallac Company.
 3. Approved Equal.
- B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

- A. Sleeves for Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Stuffing and Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 1. Link-Seal.
 2. Approved Equal.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 FIRESTOPPING

- A. Manufacturers:
 1. 3M.
 2. Hilti.
 3. Approved Equal.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
 1. Silicone Firestopping Elastomeric Firestopping: Single or Multiple component silicone elastomeric compound and compatible silicone sealant.
 2. Foam Firestopping Compounds: Single or Multiple component foam compound.
 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.

6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: Red.

2.7 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Dam Material: Permanent:
 1. Sheet metal.
- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- D. General:
 1. Furnish UL listed products.
 2. Select products with rating not less than rating of wall or floor being penetrated.
- E. Non-Rated Surfaces:
 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
 2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install damming materials to arrest liquid material leakage.
- D. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide expansion anchors.
 - 2. Steel Structural Elements: Provide beam clamps or spring steel clips.
 - 3. Concrete Surfaces: Provide expansion anchors.
 - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts or hollow wall fasteners.
 - 5. Solid Masonry Walls: Provide expansion anchors.
 - 6. Sheet Metal: Provide sheet metal screws.
 - 7. Wood Elements: Provide wood screws.
- B. Install conduit and raceway support and spacing in accordance with NEC.
- C. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- D. Install multiple conduit runs on common hangers.
- E. Supports:
 - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
 - 4. Support vertical conduit at every floor.

3.4 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.
- E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
- F. Place intumescent coating in sufficient coats to achieve rating required.
- G. Remove dam material after firestopping material has cured.
- H. Fire Rated Surface:
 - 1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1-inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.

2. Where conduit penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- I. Non-Rated Surfaces:
1. Seal opening through non-fire rated wall, partition, floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1-inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 2. Install escutcheons, floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.6 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with stuffing or fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

3.7 FIELD QUALITY CONTROL

- A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 3. Section 26 05 53 - Identification for Electrical Systems.
 - 4. Section 26 27 26 - Wiring Devices.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. Note Used.

1.3 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground More than 5 feet outside Foundation Wall: Provide thin-wall nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.
- C. Underground Within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.

- D. Under Slab on Grade: Provide thin-wall nonmetallic conduit up to the point of transition from under slab on grade to above slab on grade. Provide rigid steel conduit elbows and rigid steel conduit for slab penetrations. Provide cast or nonmetallic metal boxes.
- E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes.
- F. Wet and Damp Locations: Provide rigid steel conduit. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- G. Indoor Concealed Dry Locations: Provide electrical metallic tubing unless noted otherwise on the drawings. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- H. Indoor Exposed Dry Locations: Provide electrical metallic tubing unless noted otherwise on the drawings. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.5 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.6 SUBMITTALS

- A. Product Data: Submit for the following:
 - 1. Flexible metal conduit.
 - 2. Liquidtight flexible metal conduit.
 - 3. Nonmetallic conduit.
 - 4. Raceway fittings.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents:
 - 1. Record actual routing of conduits 2 inch and larger.
 - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC conduit from sunlight.

1.9 COORDINATION

- A. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Wheatland Tube Company.
 - 3. Approved Equal.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. AFC Cable systems.
 - 2. Southwire Company.
 - 3. Approved Equal.
- B. Product Description: Interlocked steel construction.
- C. Fittings: NEMA FB 1.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. AFC Cable Systems.
 - 2. Southwire Company.
 - 3. Approved Equal.
- B. Product Description: Interlocked steel construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.4 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Wheatland Tube Company.
 - 3. Approved Equal.
- B. Product Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: NEMA FB 1; steel set screw type.

2.5 NONMETALLIC CONDUIT

- A. Manufacturers:
 - 1. Carlon.
 - 2. Cantex.
 - 3. Approved Equal.
- B. Product Description: NEMA TC 2; Schedule 40 "thin-wall" PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.

2.6 WIREWAY

- A. Manufacturers:
 - 1. Hoffman.
 - 2. B-Line.
 - 3. Approved Equal.
- B. Product Description: General purpose type wireway for indoor use. Raintight type wireway for outdoor use.
- C. Knockouts: None.
- D. Cover: Hinged cover. Provide full gaskets for raintight type.
- E. Fittings: Lay-in type.
- F. Finish: Rust inhibiting primer coating with gray enamel finish.

2.7 OUTLET BOXES

- A. Manufacturers:
 - 1. RACO.
 - 2. Carlon.
 - 3. Approved Equal.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2-inch male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- C. Nonmetallic Outlet Boxes: NEMA OS 2.
- D. Cast Boxes: NEMA FB 1, Type FD, cast ferrous alloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- E. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- F. Wall Plates for Unfinished Areas: Furnish raised surface covers.

2.8 PULL AND JUNCTION BOXES

- A. Manufacturers:

1. Hoffman.
 2. RACO.
 3. Approved Equal.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
1. Material: Galvanized cast iron.
 2. Cover: Furnish with ground flange, neoprene gasket, and stainless-steel cover screws.
- D. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
1. Material: Galvanized cast iron.
 2. Cover: Nonskid cover with neoprene gasket and stainless-steel cover screws.
 3. Cover Legend: "ELECTRIC".
- E. Concrete composite Handholes: Die-molded, concrete composite hand holes:
1. Cable Entrance: Pre-cut cable entrance at center bottom of each side.
 2. Cover: Concrete composite, weatherproof cover with nonskid finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Concealed abandoned raceway shall remain.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- E. Extend existing raceway and box installations using materials and methods as specified.
- F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit under slab from point-to-point.
- K. Maintain clearance between raceway and piping for maintenance purposes.
- L. Maintain 12-inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- M. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- N. Bring conduit to shoulder of fittings; fasten securely.
- O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- P. Install conduit hubs to fasten conduit to cast boxes.
- Q. Install no more than equivalent of three 90-degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams.
- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

- S. Install fittings to accommodate expansion and deflection where raceway crosses control and expansion joints.
- T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- W. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.
- B. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.

3.6 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements.

- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.
- C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused openings in boxes.

3.8 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Labels.
 - 3. Wire markers.
 - 4. Underground Warning Tape.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
- B. Samples:
 - 1. Submit two nameplates, 4 x 4 inch in size illustrating materials and engraving quality.

1.3 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 QUALITY ASSURANCE

- A. Not Used.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years' experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept identification products on site in original containers. Inspect for damage.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.
- B. Letter Size:
 - 1. 1/8-inch-high letters for identifying individual equipment and loads.
- C. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

- A. Labels: Machine generated vinyl adhesive tape type, with 3/16-inch black letters on white background.

2.3 WIRE MARKERS

- A. Manufacturers:
 - 1. Brady.
 - 2. Ideal Industries.
 - 3. Approved Equal.
- B. Description: Vinyl coated cloth tape type wire markers.
- C. Legend:
 - 1. Power and Lighting Circuits: Branch circuit number.
 - 2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams.

2.4 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 - 1. Brady.
 - 2. Ideal Industries.
 - 3. Approved Equal.
- B. Description: 3-inch-wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 EXISTING WORK

- A. Install identification on existing equipment to remain in accordance with this section.
- B. Install identification on unmarked existing equipment.
- C. Replace lost nameplates.

3.3 INSTALLATION

A. GENERAL

1. Where mixed voltages are used in one building (e.g. 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system shall be labeled for voltage in addition to other requirements listed herein.
2. All branch circuit and power panels shall be identified with the same symbol used in circuit directory in main distribution center.
3. Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent. Install all labels firmly as recommended by the label manufacturer. Labels shall be installed plumb and neatly on all equipment.
4. Install nameplates parallel to equipment lines.
5. Secure nameplates to equipment fronts using screws, rivets or manufacturer approved adhesive or cement.
6. Embossed tape will not be permitted for any application.
7. Provide a sign at the service-entrance equipment indicating type and location of on-site emergency power sources and on-site legally required standby power sources, per NEC 700.7 and NEC 701.7.
8. Fire pump disconnects shall be marked as "Fire Pump Disconnecting Means", per NEC 695.4(B)(3)(c).
9. Provide a sign at each service disconnect indicating "Service Disconnect", and locate at the switch or circuit breaker, per NEC 230.70(B).

B. JUNCTION AND PULLBOX IDENTIFICATION

1. The following junction and pullboxes shall be identified utilizing spray-painted covers:

<u>System</u>	<u>Color(s)</u>
Secondary Power – 480Y/277V	Brown
Secondary Power – 208Y/120V, 240/120V	White
Emergency System – Life Safety Branch (NEC 700) – 480Y/277V	Brown/Red
Emergency System – Life Safety Branch (NEC 700) – 208Y/120V	White/Red
Legally Required Standby System (NEC 701) – 480Y/277V	Brown/Blue
Legally Required Standby System (NEC 701) – 208Y/120V	White/Blue
Optional Standby System (NEC 702) – 480Y/277V	Brown/Yellow
Optional Standby System (NEC 702) – 208Y/120V	White/Yellow
Fire Alarm	Red
Temperature Control	Green
Door Control and Door Monitoring System	Orange
Sound and Intercom Systems	Gray
Video Surveillance System	Yellow
Data	Blue

2. Additional required junction and pullbox identification shall include:
- Provide circuit numbers and source panel designations for power wiring junction boxes. Other system junction boxes shall be identified as shown on details or approved shop drawings.
 - Where exposed, junction boxes larger than 8" square shall utilize engraved nameplates with ½" minimum letter height. Identify system source(s) and load(s) served.
 - Where exposed, 8" square and smaller junction boxes shall utilize machine generated, adhesive labels.
 - Where located above an accessible ceiling, junction boxes shall utilize machine generated, adhesive labels.

C. POWER, CONTROL AND SIGNAL WIRE IDENTIFICATION

1. Provide wire labels on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control and signal wiring.
2. All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall be labeled as soon as it is terminated including wiring used for temporary purposes.

D. NAMEPLATE ENGRAVING FOR ELECTRICAL EQUIPMENT

1. Provide nameplates of minimum letter height as scheduled below.
- Distribution Panelboards, Branch Panelboards, Switchboards and Motor Control Centers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and room location of the source. Panelboards serving NEC 700, 701 or 702 loads shall identify which branch they serve.
 - Circuit Breakers, Switches, and Motor Starters in Distribution Panelboards, Switchboards and Motor Control Centers: 1/2 inch (13 mm); identify circuit and load served, including location.
 - Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: ½ inch (13 mm); identify source and load served.
 - Transformers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify primary and secondary voltages, primary source and location, and secondary load and location.

- E. PANELBOARD DIRECTORIES
 - 1. Typed directories for panels must be covered with clear plastic, and have a metal frame. Room number on directories shall be Plan numbers unless Owner so specifies.

- F. DEVICE PLATES
 - 1. Each device plate for switches and receptacles shall receive an adhesive type label on the front of the plate indicating the panel and circuit number serving the device.

- G. Wire Marker Installation:
 - 1. Install wire marker for each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.

- H. Underground Warning Tape Installation:
 - 1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes wall switches; wall dimmers; receptacles; multioutlet assembly; and device plates and decorative box covers.
- B. Related Sections:
 - 1. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

1.5 EXTRA MATERIALS

- A. None Required.

PART 2 PRODUCTS

2.1 WALL SWITCHES

- A. Manufacturers:
 - 1. Pass and Seymour/Legrand.
 - 2. Leviton.
 - 3. Approved Equal.
- B. Product Description: NEMA WD 1, Heavy-Duty, AC only general-use snap switch.
- C. Body and Handle: Ivory plastic with toggle handle.
- D. Ratings:
 - 1. Voltage: 120-277 volts, AC.
 - 2. Current: 20 amperes.

2.2 RECEPTACLES

- A. Manufacturers:
 - 1. Pass and Seymour/Legrand.
 - 2. Leviton.
 - 3. Approved Equal.
- B. Product Description: NEMA WD 1, Heavy-duty general use receptacle.
- C. Device Body: Ivory plastic.
- D. Configuration: NEMA WD 6, type as indicated on Drawings.
- E. Convenience Receptacle: Type 5-20.
- F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.3 WALL PLATES

- A. Manufacturers:
 - 1. Pass and Seymour/Legrand.
 - 2. Leviton.
 - 3. Approved Equal.
- B. Decorative Cover Plate: Ivory, smooth nylon.
- C. Jumbo Cover Plate: Ivory, smooth nylon.
- D. Weatherproof Cover Plate: In-Use type gasketed cast metal plate with hinged cast metal device cover.
- E. Exposed Dry Location Cover Plate: Raised surface cover for use with required box type.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify outlet boxes are installed at proper height.
- B. Verify wall openings are neatly cut and completely covered by wall plates.
- C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Clean debris from outlet boxes.

3.3 EXISTING WORK

- A. Disconnect and remove abandoned wiring devices.

- B. Modify installation to maintain access to existing wiring devices to remain active.
- C. Clean and repair existing wiring devices to remain or to be reinstalled.

3.4 INSTALLATION

- A. Install devices plumb and level.
- B. Install switches with OFF position down.
- C. Install receptacles with grounding pole on bottom.
- D. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.
- E. Install wall plates on flush mounted switches, receptacles, and blank outlets.
- F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- G. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.
- H. Use jumbo size plates for outlets installed in masonry walls.
- I. Install raised surface galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Install wall switch 48 inches above finished floor.
- B. Install convenience receptacle 24 inches above finished floor.
- C. Install convenience receptacle 6 inches above back splash of counter.

3.6 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fuses.

1.2 REFERENCE STANDARDS

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.3 SUBMITTALS

- A. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

1.5 MAINTENANCE MATERIALS

- A. Extra Materials:
 - 1. Furnish three spare fuses of each Class, size, and rating installed.

1.6 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Bussman.
 - 2. Littelfuse.
 - 3. Mersen.

2.2 DESIGN REQUIREMENTS

- A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment. Design system to maintain component damage within acceptable levels during faults.

- B. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays. Design system to maintain operation of device closest to fault operates.

2.3 FUSE PERFORMANCE REQUIREMENTS

- A. Motor Load Feeder Switches: Class RK5 time delay.

2.4 FUSES

- A. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.
- B. Voltage: Rating suitable for circuit phase-to-phase voltage.

2.5 CLASS RK5 FUSES

- A. Dimensions and Performance: NEMA FU 1.
- B. Voltage: Rating suitable for circuit phase-to-phase voltage.

PART 3 EXECUTION

3.1 DOMOLITION

- A. Remove fuses from abandoned circuits.
- B. Maintain access to existing fuses and other installations remaining active and requiring access. Modify installation or provide access panel.

3.2 INSTALLATION

- A. Install fuse with label oriented so manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 28 19
ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.

- B. Related Requirements:
 - 1. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 2. Section 26 05 53 - Identification for Electrical Systems.
 - 3. Section 26 28 13 - Fuses.

1.2 REFERENCE STANDARDS

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 - 1. Square D.
 - 2. Approved Equal.

- B. Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.

- C. Operation:
 - 1. Switch Ratings
 - a. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
 - b. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R fuses.

- D. Materials:
 - 1. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.
 - 2. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - a. Interior Dry Locations: Type 1.
 - b. Exterior Locations: Type 3R.
 - 3. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.
 - 4. Furnish switches with entirely copper current carrying parts.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 - 1. Square D.
 - 2. Approved Equal.

- B. Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.

- C. Operation:
 - 1. Switch Ratings
 - a. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
 - b. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when protected by Class R fuses.

- D. Materials:
 - 1. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - a. Interior Dry Locations: Type 1.
 - b. Exterior Locations: Type 3R.
 - 2. Furnish switches with entirely copper current carrying parts.

PART 3 EXECUTION

3.1 DEMOLITION

- A. Disconnect and remove abandoned enclosed switches.
- B. Maintain access to existing enclosed switches and other installations remaining active and requiring access. Modify installation or provide access panel.

3.2 INSTALLATION

- A. Install enclosed switches where indicated.
- B. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.
- C. Height: 5 feet to operating handle.
- D. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.
- E. Install engraved plastic nameplates in accordance with Section 26 05 53. Engrave nameplates with the equipment served and the panel and circuit number supplying the switch.
- F. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.3 FIELD QUALITY CONTROL

- A. Inspect for physical damage, proper alignment, anchorage, and grounding.
- B. Check proper installation and tightness of connections.

3.4 CLEANING

- A. Clean existing enclosed switches to remain or to be reinstalled.
- B. Clean new enclosed switches prior to project completion.

END OF SECTION 262819

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes manual and magnetic motor controllers in individual enclosures.
- B. Related Sections:
 - 1. Section 26 28 13 - Fuses.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 2. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - 3. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
 - 4. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
 - 5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. Underwriters Laboratories Inc.:
 - 1. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.3 SUBMITTALS

- A. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations and ratings of enclosed controllers.
- B. Operation and Maintenance Data: Submit Replacement parts list for controllers.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

PART 2 PRODUCTS

2.1 MANUAL MOTOR CONTROLLER

- A. Manufacturers:
 - 1. Square D.
 - 2. Approved Equal.
- B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, and toggle operator.
- C. Enclosure: NEMA ICS 6, Type to meet conditions of installation.

2.2 MOTOR STARTING SWITCH

- A. Manufacturers:
 - 1. Square D.
 - 2. Approved Equal.
- B. Product Description: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with toggle operator.
- C. Enclosure: NEMA ICS 6, Type to meet conditions of installation.

2.3 FULL-VOLTAGE NON-REVERSING CONTROLLERS

- A. Manufacturers:
 - 1. Square D.
 - 2. Approved Equal.
- B. Product Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- C. Control Voltage: 120 volts, 60 Hertz. To be coordinated/verified with the temperature controls contractor.
- D. Overload Relay: The overload relay shall be solid state, self-powered, provide phase loss and phase unbalance protection, have a permanent tamper guard and be ambient insensitive. The overload shall have a mechanical test function.
- E. Product Features:
 - 1. Auxiliary Contacts: NEMA ICS 2, 2 field convertible contacts in addition to seal-in contact.
 - 2. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty type.
 - 3. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
 - 4. Indicating Lights: NEMA ICS 2, red "RUN" LED Push-to-test in front cover.
 - 5. Selector Switches: NEMA ICS 2, Rotary type HAND-OFF-AUTO in front cover.
 - 6. Control Power Transformers: 120 volt secondary, 50 VA minimum, in each motor starter. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
- F. Combination Controllers: Combine motor controllers with disconnect in common enclosure, using fusible switch conforming to NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips:

Designed to accommodate NEMA FU 1, Class R fuses. Obtain IEC Class 2 coordinated component protection.

- G. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.1 EXISTING WORK

- A. Disconnect and remove abandoned enclosed motor controllers.
- B. Maintain access to existing enclosed motor controllers and other installations to remain active and to require access. Modify installation or provide access panel.
- C. Clean and repair existing enclosed motor controllers to remain or to be reinstalled.

3.2 INSTALLATION

- A. Install enclosed controllers plumb. Provide supports in accordance with Section 26 05 29.
- B. Height: 5 feet to operating handle.
- C. Install fuses for fusible switches. Refer to Section 26 28 13 for product requirements.
- D. Set solid state overload relays in motor controllers to match installed motor characteristics.
- E. Install engraved plastic nameplates. Refer to Section 26 05 53 for product requirements and location.
- F. Neatly type label and place inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.3 FIELD QUALITY CONTROL

- A. Inspect for physical damage, proper alignment, anchorage, and grounding.
- B. Check proper installation and tightness of connections.

END OF SECTION

SECTION 26 41 00

FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Air terminals.
 - 2. Interconnecting conductors.
 - 3. Grounding.
 - 4. Bonding for lightning protection.

1.2 REFERENCES

- A. Lightning Protection Institute:
 - 1. LPI 175 - Standard of Installation.
- B. National Fire Protection Association:
 - 1. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- C. Underwriters Laboratories Inc.:
 - 1. UL 96 - Lightning Protection Components.
 - 2. UL 96A - Installation Requirements for Lightning Protection Systems.

1.3 SYSTEM DESCRIPTION

- A. Description: Modify the existing facility lightning protection system to allow for removal and reinstallation of roof-top units and fans indicated as being replaced on the Drawings. Disconnect lightning protection system cables, and air terminals from existing equipment for removal of equipment. Reconnect existing lightning protection system cables, air terminals to replaced equipment after equipment has been installed.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.
- C. Product Data: Submit catalog sheets showing dimensions and materials of each component and include indication of listing in accordance with UL 96.
- D. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- F. Certificate of Compliance: Submit certificate from Underwriter's Laboratories indicating approval of lightning protection systems.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 780.
- B. Perform Work in accordance with UL 96A and furnish Master Label.
- C. Perform Work in accordance with LPI-175 and furnish LPI Certification.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in lightning protection equipment with minimum three years documented experience and member of Lightning Protection Institute.
- B. Installer: Authorized installer of manufacturer with minimum three years documented experience and certified by Lightning Protection Institute.
- C. Inspection Agency: Company or individual specializing in lightning protection inspecting with minimum three years documented experience and member of Lightning Protection Institute.

1.8 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Coordinate locations of all replaced air terminals on replaced equipment.
- B. Coordinate Work with roofing and exterior and interior finish installations.

PART 2 PRODUCTS

2.1 COMPONENTS

- A. Product Listing: UL 96.
- B. Air Terminals:
 - 1. Material: Aluminum.
 - 2. Configuration: Solid.
 - 3. Use adhesive base for single-ply roof installations.
 - 4. Air Terminal for Chimney: Lead-coated copper.
- C. Conductors:
 - a. Material: Aluminum.

- D. Conduit: PVC, Schedule 40.
- E. Connectors and Splicers: Aluminum.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with the more stringent of NFPA 780, UL 96A, and LPI-175.
- B. Connect conductors using exothermic welding process. Protect adjacent construction elements and finishes from damage.
- C. Conductors shall be concealed within building finishes.
- D. Bond exterior metal bodies on building to lightning protection system and provide intermediate level interconnection loops 60 feet on center.

3.2 FIELD QUALITY CONTROL

- A. Perform inspection and testing in accordance with UL 96A.

END OF SECTION.

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