

Project Manual

for

Yuma County Somerton Library HVAC Replacement

September 2025

Sternco Project #4215



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YUMA COUNTY SOMERTON LIBRARY HVAC REPLACEMENT
SOMERTON AZ STERCO ENGINEERS JOB 4215 SEPTEMBER 2025

Discipline: **MECHANICAL ENGINEER**

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YUMA COUNTY SOMERTON LIBRARY HVAC REPLACEMENT
SOMERTON AZ STERNCO ENGINEERS JOB 4215 SEPTEMBER 2025

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END OF SECTION

SECTION 01 10 00

SUMMARY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Contract description.
- B. Contractor's use of site and premises.
- C. Work sequence.
- D. Owner occupancy.
- E. Specification Conventions.

1.2 CONTRACT DESCRIPTION

- A. The work of this project is shown on the drawings titled "*Yuma County Somerton Library HVAC Replacement.*" The Contractor is to familiarize themselves with the sheet index. Execute the work shown on the contract drawings for a complete and total HVAC system replacement, including all required, related, and directed work.
- B. Work of the Contract is identified in the following documents:
 - 1. Sealed Engineering Drawings, any issued addenda, and any supplemental instructions, including but not limited to sketches, directives, and lists created and distributed during this project.
 - 2. Project Manual, Solicitation, and Specifications.

1.3 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Limit use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Use of site and premises by the public.

1.4 WORK SEQUENCE

- A. Construct Work in stages or phases to accommodate Owner's occupancy requirements during construction period. Coordinate construction schedule and operations with Owner.

1.5 OWNER OCCUPANCY

- A. The Owner will occupy the site during the entire period of construction.
- B. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.

- C. Schedule the Work to accommodate Owner occupancy.

1.6 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 30 00

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Owner's project manager.
- B. Coordination and project conditions.
- C. Field engineering.
- D. Preconstruction meeting.
- E. Site mobilization meeting.
- F. Progress meetings.
- G. Pre-installation meetings.
- H. Cutting and patching.
- I. Special procedures.

1.2 OWNER'S PROJECT MANAGER

- A. The Owner has retained a Project Manager to administer design, bidding, and construction phase services on behalf of the Owner. The Contractor shall direct all formal communications, submittals, RFIs, pay applications, change order requests, meeting invitations, and project correspondence through the Owner's Project Manager, with copies to the Owner. The Contractor shall keep the Owner's Project Manager fully informed of project status, scheduling, and activities at all times.

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, with provisions for accommodating items installed later.
- B. Verify utility requirements and characteristics of operating equipment are compatible with building 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, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.
- E. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.
- F. After Owner resumes full 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.

1.4 FIELD ENGINEERING

- A. Confirm drawing dimensions and elevations.
- B. If conflict issues arise, the contractor shall prepare dimensional sketches as requested or needed to resolve conflicts.

1.5 PRECONSTRUCTION MEETING

- A. Contractor will schedule meeting after 14 days of notice to proceed.
- B. Attendance Required: Owner, Project Manager, Engineer, and Contractor.
- C. Agenda:
 - 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. Submittal register of all submittals planned for submission and approval.
 - 6. Identification of equipment lead times that could impact the project.
 - 7. Designation of personnel representing parties in Contract and Engineer.
 - 8. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - 9. Scheduling and schedule updates.
 - 10. Site access and personnel.
 - 11. Safety procedures.
- D. Record minutes and distribute electronically within two days after meeting to participants, with distribution to Owner, Project Manager, Engineer, and those affected by decisions made.

1.6 SITE MOBILIZATION MEETING

- A. Contractor will schedule meeting at Project site prior to Contractor occupancy.

- B. Attendance required: Owner, Project Manager, Engineer, Special Consultants, Contractor, Contractor's Superintendent, and major Subcontractors.
- C. Agenda:
 - 1. Use of premises by Owner and Contractor.
 - 2. Safety.
 - 3. Owner's requirements and occupancy.
 - 4. Construction facilities and controls provided by Owner.
 - 5. Temporary utilities provided by Owner.
 - 6. Security and housekeeping procedures.
 - 7. Schedules.
 - 8. Application for payment procedures.
 - 9. Procedures for testing.
 - 10. Procedures for maintaining record documents.
 - 11. Requirements for start-up of equipment.
 - 12. Inspection and acceptance of equipment put into service during construction period.
 - 13. Any item not clarified per 1.4.C above.
- D. Record minutes and distribute electronically within two days after meeting to participants, with distribution to Owner, Project Manager, Engineer, and those affected by decisions made.

1.7 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum weekly intervals.
- B. Contractor will make arrangements for meetings, prepare agenda with copies for participants and preside at meetings.
- C. Attendance Required: Job superintendent, major subcontractors and suppliers, Owner, Project Manager, and Engineer, as appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 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.

- E. Record minutes and distribute electronically within two days after meeting to participants, with distribution to Owner, Project Manager, Engineer, and those affected by decisions made.

1.8 PRE-INSTALLATION MEETINGS

- A. When required in individual specification sections, convene pre-installation meetings at Project site prior to commencing work of specific section.
- B. Require attendance of parties directly affecting, or affected by, Work of specific section.
- C. Notify Engineer and Project Manager four days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of installation, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer, Owner, and those affected by decisions made.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 CUTTING AND PATCHING

- A. Employ skilled and experienced installer to perform cutting and patching.
- B. Submit written request in advance of cutting or altering elements affecting:
 - 1. Structural integrity of element.
 - 2. Integrity of weather-exposed or moisture-resistant elements.
 - 3. Efficiency, maintenance, or safety of element.
 - 4. Visual qualities of sight exposed elements.
 - 5. Work of Owner or separate contractor.
- C. Execute cutting, fitting, and patching to complete Work, and to:
 - 1. Fit the several parts together, to integrate with other Work.
 - 2. Uncover Work to install or correct ill-timed Work.
 - 3. Remove and replace defective and non-conforming Work.
 - 4. Remove samples of installed Work for testing.
 - 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- D. Execute work by methods to avoid damage to other Work, and to provide proper surfaces to receive patching and finishing.
- E. Cut masonry and concrete materials using masonry saw or core drill.

- F. Restore Work with new products in accordance with requirements of Contract Documents.
- G. Fit Work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material, to full thickness of penetrated element.
- J. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.
- K. Identify hazardous substances or conditions exposed during the Work to Owner, Project Manager, and Engineer for decision or remedy.

3.2 SPECIAL PROCEDURES

- A. Materials: As specified in product sections; match existing with new products and salvaged products for patching and extending work.
- B. Employ skilled and experienced installer to perform alteration 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, including rotted wood, corroded metals, and deteriorated masonry and concrete. 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. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.
- H. Remove, cut, and patch Work in manner to minimize damage and to permit restoring products and finishes to original or specified condition.
- I. Refinish existing visible surfaces to remain in renovated rooms and spaces, to specified or renewed condition for each material, with neat transition to adjacent finishes.
- J. Where new Work abuts or aligns with existing, provide smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.

- K. When finished surfaces are cut so that smooth transition with new Work is not possible, terminate existing surface along straight line at natural line of division and submit recommendation to Engineer for review.
- L. Where change of plane of 1/4 inch or more occurs, submit recommendation for providing smooth transition to Engineer for review.
- M. Restore, clean, or replace any building surface that may be negatively influenced by the work to the satisfaction of the Engineer and the Owner. (You Damage it you will replace it.)
- N. Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections.
- O. Finish surfaces as specified in individual product sections.

END OF SECTION

SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Format.
- B. Schedules.
- C. Submittals.
- D. Review and evaluation.
- E. Updating schedules.
- F. Distribution.

1.2 FORMAT

- A. Listings: Reading from left to right, in ascending order for each activity. Identify each activity with applicable specification section number.
- B. Scale and Spacing: To allow for notations and revisions.

1.3 SCHEDULES

- A. Illustrate order and interdependence of activities and sequence of work; how start of given activity depends on completion of preceding activities, and how completion of activity may restrain start of subsequent activities.
- B. Illustrate complete sequence of construction by activity, identifying work of separate stages. Indicate dates for submittals including dates for Owner-furnished items and return of submittals; dates for procurement and delivery of critical products; and dates for installation and provision for testing. Include legend for symbols and abbreviations used.
- C. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
 - 1. Preceding and following event numbers.
 - 2. Activity description.
 - 3. Estimated duration of activity, in maximum 2-day intervals.
 - 4. Earliest start date.
 - 5. Earliest finish date.
 - 6. Actual start date.
 - 7. Actual finish date.
 - 8. Latest start date.

9. Latest finish date.
 10. Total and free float; accrue float time to Owner and to Owner's benefit.
 11. Monetary value of activity, keyed to Schedule of Values.
 12. Percentage of activity completed.
 13. Responsibility.
- D. Analysis Program: Capable of compiling monetary value of completed and partially completed activities, of accepting revised completion dates, and re-computation of scheduled dates and float.
- E. Required Sorts: List activities in sorts or groups:
1. By preceding work item or event number from lowest to highest.
 2. By longest float, then in order of early start.
 3. By responsibility in order of earliest possible start date.
 4. In order of latest allowable start dates.
 5. In order of latest allowable finish dates.
 6. Contractor's periodic payment request sorted by Schedule of Values listings or specifications sections.
 7. Listing of basic input data generating report.
 8. Listing of activities on critical path.
- F. Prepare sub-schedules for each stage of Work identified in Section 01 10 00 - Summary.
- G. Coordinate contents with schedule of values in Section 01 33 00 - Submittal Procedures.

1.4 SUBMITTALS

- A. Within 7 days after date established in Notice to Proceed, submit proposed preliminary network diagram defining planned operations for first 30 days of Work, with general outline for remainder of Work.
- B. Participate in review of preliminary and complete network diagrams jointly with Engineer and Project Manager.
- C. Within 10 days after joint review of proposed preliminary network diagram, submit draft of proposed complete network diagram for review. Include written certification that major mechanical and electrical Subcontractors have reviewed and accepted proposed schedule.
- D. Submit under transmittal letter form specified in Section 01 33 00 - Submittal Procedures.

1.5 REVIEW AND EVALUATION

- A. Participate in joint review and evaluation of network diagrams and analysis with Engineer and Project Manager at each submittal.
- B. Evaluate project status to determine work behind schedule and work ahead of schedule.

- C. After review, revise network diagrams and analysis incorporating results of review, and resubmit within 14 days.

1.6 UPDATING SCHEDULES

- A. Maintain schedules to record actual start and finish dates of completed activities.
- B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Annotate or Update diagrams to graphically depict current status of Work.
- C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
- D. Indicate changes required to maintain Date of Substantial Completion.
- E. Submit sorts required to support recommended changes.
- F. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect including effects of changes on schedules of separate contractors.

1.7 DISTRIBUTION

- A. Following joint review, distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Engineer, Project Manager, Owner, and other concerned parties.
- B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Submittal procedures.
- B. Proposed products list.
- C. Product data.
- D. Shop drawings.
- E. Samples.
- F. Design data.
- G. Test reports.
- H. Certificates.
- I. Manufacturer's instructions.
- J. Manufacturer's field reports.

1.2 SUBMITTAL PROCEDURES

- A. Provide Submittal Outline Log Reference with each submittal.
- B. Transmit each submittal with Engineer accepted form.
- C. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
- D. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.
- E. 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.
- F. Schedule submittals to expedite Project, and deliver to Engineer, Owner at business address. Coordinate submission of related items.
- G. For each submittal for review, allow 15 days excluding delivery time to and from Engineer.

- H. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
- I. Allow space on submittals for Contractor and Engineer review stamps.
- J. When revised for resubmission, identify changes made since previous submission.
- K. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

1.3 PROPOSED PRODUCTS LIST

- A. Within 7 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.

1.4 PRODUCT DATA

- A. Product Data: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Submit number of copies Contractor requires, plus 6 copies. Engineer will retain one.
- C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- E. 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.

1.5 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. Produce copies and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents purposes described in Section 01 70 00.
- 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.
 3. Make revisions and provide additional information when required by authorities having jurisdiction.
- D. Submit number of opaque reproductions Contractor requires, plus 6 copies. Engineer will retain one.
- E. 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 SAMPLES

- A. Samples: Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents as required.
- B. Samples For Selection as Specified in Product Sections:
1. Submit to Engineer for aesthetic, color, or finish selection.
 2. Submit samples of finishes from full range of manufacturers' standard colors, textures, and patterns for Engineer selection.
- C. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- D. Include identification on each sample, with full Project information.
- E. Submit number of samples specified in individual specification sections; Engineer will retain one sample.
- F. Mock up any sample or actual item at the discretion of the engineer.
- G. Reviewed samples which may be used in the Work are indicated in individual specification sections.
- H. Samples will not be used for testing purposes unless specifically stated in specification section.
- I. After review, produce duplicates and distribute in accordance with SUBMITTAL PROCEDURES article and for record documents purposes 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.

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.

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.

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 FIELD REPORTS

- A. Submit reports for Engineer's benefit as contract administrator or for Owner.
- B. Submit report in duplicate 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.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Quality control and control of installation.
- B. Tolerances.
- C. References.
- D. Labeling.
- E. Testing and inspection services.
- F. Manufacturers' field services.
- G. Examination.
- H. 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.

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, trades, or other consensus standards, comply 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 of Contract Documents, 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, nor 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 TESTING AND INSPECTION SERVICES

- A. Contractor shall test the system to the fullest per Contract documents, as directed by the engineer or the owner, and in conformance with the manufacturers start up and installation documentation.
- B. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing as required by Engineer or Owner.

1. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by an independent firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor.
- C. Limits On Testing Authority:
 1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency or laboratory may not approve or accept any portion of the Work.
 3. Agency or laboratory may not assume duties of Contractor.
 4. Agency or laboratory has no authority to stop the Work.

1.7 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions; conditions of surfaces and installation; quality of workmanship; start-up of equipment; test, adjust, and balance of equipment as applicable; and to initiate instructions when necessary.
- B. Submit qualifications of observer to Engineer 10 days in advance of required observations. Observer subject to approval of Engineer.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- D. Refer to Section 01 33 00 - SUBMITTAL PROCEDURES, MANUFACTURERS' FIELD REPORTS article.

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.

3.2 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.

- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Temporary Utilities:
 - 1. Temporary electricity.
 - 2. Temporary lighting for construction purposes.
 - 3. Temporary heating.
 - 4. Temporary cooling.
 - 5. Temporary ventilation.
 - 6. Telephone service.
 - 7. Facsimile service.
 - 8. Temporary water service.
 - 9. Temporary sanitary facilities.
- B. Construction Facilities:
 - 1. Field offices and sheds.
 - 2. Vehicular access.
 - 3. Parking.
 - 4. Progress cleaning and waste removal.
 - 5. Project identification.
 - 6. Traffic regulation.
 - 7. Fire prevention facilities.
- C. Temporary Controls:
 - 1. Barriers.
 - 2. Enclosures and fencing.
 - 3. Security.
 - 4. Water control.
 - 5. Dust control.
 - 6. Erosion and sediment control.
 - 7. Noise control.
 - 8. Pest control.
 - 9. Pollution control.
 - 10. Rodent control.
- D. Removal of utilities, facilities, and controls.

1.2 TEMPORARY ELECTRICITY

- A. Owner will pay cost of energy used. Exercise measures to conserve energy.

- B. Provide power outlets, with branch wiring and distribution boxes located as required for construction operations. Provide flexible power cords as required for portable construction tools and equipment.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain lighting for construction operations to achieve minimum lighting level of 2 watt/sq ft.
- B. Provide and maintain 1 watt/sq ft lighting to exterior staging and storage areas entire site after dark for security purposes.
- C. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps for specified lighting levels.
- D. Maintain lighting and provide routine repairs.
- E. Permanent building lighting may be utilized during construction.

1.4 TEMPORARY HEATING

- A. Existing facilities shall not be used.
- B. Provide heating devices and heat as needed to maintain specified conditions for construction operations.
- C. Enclose building prior to activating temporary heat in accordance with Enclosures article in this section.
- D. Prior to operation of permanent equipment for temporary heating purposes, verify installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.
- E. Maintain minimum ambient temperature of 50 degrees F in areas where construction is in progress, unless indicated otherwise in product sections.

1.5 TEMPORARY COOLING

- A. Existing facilities shall be used.
- B. Provide cooling devices and cooling as needed to maintain specified conditions for construction operations.
- C. Enclose building prior to activating temporary cooling in accordance with Enclosures article in this section.
- D. Prior to operation of permanent equipment for temporary cooling purposes, verify installation is approved for operation, equipment is lubricated and filters are in place.

Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

- E. Maintain maximum ambient temperature of 80 degrees F in areas where construction is in progress, unless indicated otherwise in specifications.

1.6 TEMPORARY VENTILATION

- A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- B. Utilize existing ventilation equipment. Extend and supplement equipment with temporary fan units as required to maintain clean air for construction operations.

1.7 TELEPHONE SERVICE

- A. Provide, maintain, and pay for telephone service to field office at time of project mobilization.

1.8 FACSIMILE SERVICE

- A. Provide, maintain and pay for facsimile service and dedicated telephone line to field office at time of project mobilization.

1.9 TEMPORARY WATER SERVICE

- A. Owner will pay cost of temporary water. Exercise measures to conserve energy. Utilize Owner's existing water system, extend and supplement with temporary devices as needed to maintain specified conditions for construction operations.
- B. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.

1.10 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide facilities at time of project mobilization.

1.11 FIELD OFFICES AND SHEDS

- A. Do not use permanent facilities for field offices or for storage.
- B. Construction: Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations with steps and landings at entrance doors.
 - 1. Construction: Structurally sound, secure, weather tight enclosures for office and storage spaces. Maintain during progress of Work; remove at completion of Work.
 - 2. Temperature Transmission Resistance of Floors, Walls, and Ceilings: Compatible with occupancy and storage requirements.

3. Exterior Materials: Weather resistant, finished in one color acceptable to Engineer.
 4. Interior Materials in Offices: Sheet type materials for walls and ceilings, pre-finished or painted; resilient floors and bases.
 5. Lighting for Offices: 50 ft C at desk top height, exterior lighting at entrance doors.
 6. Interior Materials in Storage Sheds: As required to provide specified conditions for storage of products.
- C. Environmental Control:
1. Storage Spaces: Heating and ventilation as needed to maintain products in accordance with Contract Documents; lighting for maintenance and inspection of products.
- D. Storage Areas and Sheds: Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products.
- E. Preparation: Fill and grade sites for temporary structures sloped for drainage away from buildings.
- F. Installation:
1. Install office spaces ready for occupancy 15 days after date fixed in Notice to Proceed.
 2. Parking: hard surfaced parking spaces for use by Owner/Engineer, connected to office by hard surfaced walk.
 3. Employee Residential Occupancy: Not allowed on Owner's property.
- G. Maintenance And Cleaning:
1. Weekly janitorial services for offices; periodic cleaning and maintenance for office and storage areas.
 2. Maintain approach walks free of mud, water, and snow.
- H. Removal: At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

1.12 VEHICULAR ACCESS

- A. Extend and relocate vehicular access as Work progress requires, provide detours as necessary for unimpeded traffic flow.
- B. Location approved by Owner.
- C. Provide unimpeded access for emergency vehicles. Maintain 20 feet wide driveways with turning space between and around combustible materials.
- D. Provide and maintain access to fire hydrants and control valves free of obstructions.
- E. Provide means of removing mud from vehicle wheels before entering streets.

- F. Use designated existing on-site roads for construction traffic.

1.13 PARKING

- A. Arrange for temporary gravel surface parking areas to accommodate construction personnel.
- B. Locate as approved by Owner.
- C. When site space is not adequate, provide additional off-site parking.
- D. Use of designated existing on-site streets and driveways used for construction traffic is permitted. Tracked vehicles not allowed on paved areas.
- E. Use of designated areas of existing parking facilities used by construction personnel is permitted.
- F. Do not allow heavy vehicles or construction equipment in parking areas.
- G. Do not allow vehicle parking on existing pavement.
- H. Permanent Pavements and Parking Facilities:
 - 1. Prior to Substantial Completion, bases for permanent roads and parking areas may be used for construction traffic.
 - 2. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.
 - 3. Use of permanent parking structures is not permitted.
- I. Maintenance:
 - 1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, snow, and ice.
 - 2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.
- J. Removal, Repair:
 - 1. Remove temporary materials and construction at Substantial Completion.
 - 2. Repair existing facilities damaged by use, to original condition.
- K. Mud From Site Vehicles: Provide means of removing mud from vehicle wheels before entering streets.

1.14 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 weekly and dispose off-site.
- E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.15 PROJECT IDENTIFICATION

- A. Project Identification Sign:
 - 1. One painted sign, 32 sq ft area, bottom 6 feet above ground.
 - 2. Content:
 - a. Project title, logo and name of Owner as indicated on Contract Documents.
 - b. Names and titles of Engineer.
 - c. Name of Prime Contractor.
 - d. All CDBG, Davis Bacon and EEOC required postings
 - 3. Graphic Design, Colors, Style of Lettering: Designated by Engineer.
- B. Project Informational Signs:
 - 1. Painted informational signs of same colors and lettering as Project Identification sign, or standard products; size lettering for legibility at 100 feet distance.
 - 2. Provide sign at each field office, storage shed, and directional signs to direct traffic into and within site. Relocate as Work progress requires.
 - 3. Provide municipal, state traffic agency directional traffic signs to and within site.
 - 4. No other signs are allowed without Owner permission except those required by law.
- C. Design sign and structure to IBC 2006, seismic hazard level "A", site class "D".
- D. Sign Painter: Experienced as professional sign painter for minimum three years.
- E. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.
- F. Show content, layout, lettering, color, sizes, and grades of members.
- G. Sign Materials:
 - 1. Structure and Framing: New, wood, structurally adequate.
 - 2. Sign Surfaces: Exterior grade plywood with medium density overlay, minimum 3/4 inches thick, standard large sizes to minimize joints.
 - 3. Rough Hardware: Galvanized.
 - 4. Paint and Primers: Exterior quality, two coats; sign background of color as selected.
 - 5. Lettering: Exterior quality paint, contrasting colors as selected.
- H. Installation:

1. Install project identification sign within 15 days after date fixed by Notice to Proceed.
 2. Erect at location of high public visibility adjacent to main entrance to site.
 3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind and seismic loadings.
 4. Install sign surface plumb and level, with butt joints. Anchor securely.
 5. Paint exposed surfaces of sign, supports, and framing.
- I. Maintenance: Maintain signs and supports clean, repair deterioration and damage.
- J. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.16 TRAFFIC REGULATION

- A. Signs, Signals, And Devices:
1. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As approved by authority having jurisdiction.
 2. Automatic Traffic Control Signals: As approved by local jurisdictions.
 3. Traffic Cones and Drums, Flares and Lights: As approved by authority having jurisdiction.
 4. Flagperson Equipment: As required by authority having jurisdiction.
- B. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.
- C. Flares and Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.
- D. Haul Routes:
1. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.

1.17 FIRE PREVENTION FACILITIES

- A. Prohibit smoking with buildings under construction and demolition.
- B. Establish fire watch for cutting and welding and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.
- C. Portable Fire Extinguishers: NFPA 10; 10 pound capacity, 4A-60B: C UL rating.
1. Provide one fire extinguisher at each stair on each floor of buildings under construction and demolition.
 2. Provide minimum one fire extinguisher in every construction trailer and storage shed.
 3. Provide minimum one fire extinguisher on roof during roofing operations using heat producing equipment.

1.18 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by authorities having jurisdiction for public rights-of-way and for public access to existing building.
- C. Provide protection for plants designated to remain. Replace damaged plants.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.19 ENCLOSURES AND FENCING

- A. Construction: Commercial grade chain link fence.
- B. Provide 6 feet high fence around construction site; equip with vehicular and pedestrian gates with locks.
- C. Exterior Enclosures:
 - 1. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.
- D. Interior Enclosures:
 - 1. Provide temporary partitions and ceilings to separate work areas from Owner occupied areas, to prevent penetration of dust and moisture into Owner occupied areas, and to prevent damage to existing materials and equipment.
 - 2. Construction: Framing and plywood or gypsum board sheet materials with closed joints and sealed edges at intersections with existing surfaces:
 - 3. Paint surfaces exposed to view from Owner occupied areas.

1.20 SECURITY

- A. Security Program:
 - 1. Protect Work existing premises and Owner's operations 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 directed by Engineer.
- B. Entry Control:
 - 1. Restrict entrance of persons and vehicles into Project site and existing facilities.
 - 2. Allow entrance only to authorized persons with proper identification.
 - 3. Maintain log of workers and visitors, make available to Owner on request.
 - 4. Control entrance of persons and vehicles related to Owner's operations.

5. Coordinate access of Owner's personnel to site in coordination with Owner's security forces.
 - C. Personnel Identification:
 1. Provide identification badge to each person authorized to enter premises.
 2. Badge To Include: Personal photograph, name expiration date and employer.
 3. Maintain list of accredited persons, submit copy to Owner on request.
 4. Require return of badges at expiration of their employment on the Work.
 - D. Restrictions:
 1. Do not allow cameras on site or photographs taken except by written approval of Owner.
 2. Do no work on days indicated in Engineer-Contractor Agreement. Coordinate with Owner.
- 1.21 WATER CONTROL
- A. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
- 1.22 DUST CONTROL
- A. Execute Work by methods to minimize raising dust from construction operations.
 - B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.
- 1.23 EROSION AND SEDIMENT CONTROL
- A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
 - B. Minimize surface area of bare soil exposed at one time.
 - C. Provide temporary measures including berms, dikes, and drains, and other devices to prevent water flow.
 - D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
 - E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.
- 1.24 NOISE CONTROL
- A. Provide methods, means, and facilities to minimize noise from and noise produced by construction operations.

1.25 PEST CONTROL

- A. Provide methods, means, and facilities to prevent pests and insects from damaging the Work entering facility.

1.26 POLLUTION CONTROL

- A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.
- B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

1.27 RODENT CONTROL

- A. Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

1.28 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Final Application for Payment inspection.
- B. Remove underground installations to minimum depth of 2 feet.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

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. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- I. 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.
- B. 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.

1.6 PRODUCT SUBSTITUTION PROCEDURES

- A. Instructions to Bidders specify time restrictions for submitting requests for Substitutions during the bidding period, in accordance with requirements specified in this section.
- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- C. A request constitutes a representation that Bidder:
 - 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 and Engineer for review or redesign services associated with re-approval by authorities having jurisdiction.
- D. 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.

- E. Substitution Submittal Procedure:
1. Submit 6 copies of Request for Substitution for consideration. 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

2.1 EQUIPMENT ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Include lugs for terminal box.
- B. Cord and Plug: Furnish minimum 6-foot cord and plug including grounding connector for connection to electric wiring system. Cord of longer length is specified in individual specification sections.

PART 3 EXECUTION - Not Used

END OF SECTION

REQUEST FOR SUBSTITUTION

Project: _____ Substitution Request Number: _____
From: _____
To: _____ Date: _____
A/E Project Number: _____
Re: _____ Contract For: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____
Manufacturer: _____ Address: _____ Phone: _____
Trade Name: _____ Model No: _____
Installer: _____ Address: _____ Phone: _____
History: ☐ New Product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old
Differences between proposed substitution and specified product: _____

REQUIRED: ☐ Point-by-point comparative data attached

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____
Address: _____ Owner: _____
Date Installed: _____

Proposed Substitution affects other parts of Work: ☐ No ☐ Yes: explain _____

Savings to Owner for accepting substitution: _____ (\$ _____)

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Closeout procedures.
- B. Final cleaning.
- C. Starting of systems.
- D. Demonstration and instructions.
- E. Protecting installed construction.
- F. Project record documents.
- G. Operation and maintenance data.
- H. Manual for materials and finishes.
- I. Manual for equipment and systems.
- J. Spare parts and maintenance products.
- K. Product warranties and product bonds.
- L. Maintenance service.

1.2 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.
- B. Provide submittals to Engineer required by authorities having jurisdiction.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- D. Owner will occupy all portions of building as specified in Section 01 10 00 - SUMMARY.

1.3 FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.

- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
- D. Replace filters of operating equipment.
- E. Clean debris from roofs, gutters, downspouts, and drainage systems.
- F. Clean site; sweep paved areas, rake clean landscaped surfaces.
- G. Remove waste and surplus materials, rubbish, and construction facilities from site.

1.4 STARTING OF SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- 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 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.

1.5 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Demonstrate Project equipment and instruct in classroom environment located at site and instructed by qualified manufacturer's representative who is knowledgeable about the Project.

- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at designated location.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. Required instruction time for each item of equipment and system is specified in individual sections.

1.6 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.

1.7 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.
- D. Record information concurrent with construction progress, not less than weekly.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 2. Field changes of dimension and detail.
 - 3. Details not on original Contract drawings.
- G. Submit documents to Engineer with claim for final Application for Payment for approval.

1.8 OPERATION AND MAINTENANCE DATA

- A. Submit data bound in 8-1/2 x 11-inch (A4) text pages, three D side ring binders with durable plastic covers.
- 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. Air and water balance reports.
 - c. Certificates.
 - d. Photocopies of warranties.

1.9 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes 15 days prior to final inspection. Draft copy be reviewed and returned after final inspection, with Engineer comments. Revise content of document sets as required prior to final submission.
- D. Submit two sets of revised final volumes in final form within 10 days after final inspection.
- E. 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.
- F. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
- G. Include color coded wiring diagrams as installed.
- H. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and special operating instructions.
- I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- J. Include servicing and lubrication schedule, and list of lubricants required.
- K. Include manufacturer's printed operation and maintenance instructions.
- L. Include sequence of operation by controls manufacturer.

- M. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- N. Include control diagrams by controls manufacturer as installed.
- O. Include Contractor's coordination drawings, with color coded piping diagrams as installed.
- P. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- Q. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- R. Include test and balancing reports as specified in Section 01 40 00 - QUALITY REQUIREMENTS.
- S. Additional Requirements: As specified in individual product specification sections.
- T. Include listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS

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

1.11 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
- B. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.
- C. Verify documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.
- E. Include Table of Contents and assemble in three D side ring binder with durable plastic cover.
- F. Submit prior to final Application for Payment.
- G. Time Of Submittals:

1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten days after acceptance.
2. Make other submittals within ten days after Date of Substantial Completion, prior to final Application for Payment.
3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Identification for HVAC Piping and Equipment.
 - 2. Sleeves.
 - 3. Mechanical sleeve seals.
 - 4. Formed steel channel.

1.2 SUBMITTALS

- A. Product Data for Pipe and Equipment Identification: Submit for mechanical identification manufacturers catalog literature for each product required.

1.3 QUALITY ASSURANCE

- A. Perform Work in accordance with Yuma County standards.
- B. Maintain one copy of each document on site.

PART 2 PRODUCTS

2.1 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

- A. Furnish materials in accordance with Yuma County standards.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.
- C. Plastic Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.
- D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.
- E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.
- F. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.2 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.

2.3 MECHANICAL SLEEVE SEALS

- A. Furnish materials in accordance with Yuma County standards.
- 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.

2.4 FORMED STEEL CHANNEL

- A. Furnish materials in accordance with Yuma County standards.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

- A. Install plastic nameplates with adhesive.
- B. Install plastic tags with corrosion resistant metal chain.

3.3 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 escutcheons at finished surfaces.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Testing, adjusting, and balancing of air systems.
 - 2. Testing, adjusting, and balancing of hydronic and refrigerating systems.
 - 3. Measurement of final operating condition of HVAC systems.
 - 4. Sound measurement of equipment operating conditions.
 - 5. Vibration measurement of equipment operating conditions.
- B. Related Sections:
 - 1. Section 23 09 23 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.

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. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Prior to commencing Work, submit proof of latest calibration date of each instrument.
- C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or NEBB Report forms.
- D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- E. 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.

- F. Submit draft copies of report for review prior to final acceptance of Project.
- G. Furnish reports electronically as a PDF, complete with table of contents page and bookmarks. Include set of drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. 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 Yuma County standards.
- B. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- C. Prior to commencing Work, confirm each instrument to be used has a current calibration.

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 NEBB.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

- A. Section 01 10 00 - Summary: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

- B. Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 PRE-DEMOLITION TAB WORK

- A. Prior to demolition, perform TAB work as specified on drawings and following procedures in this specification. Submit a field report of airflow measurements and discrepancies.

3.2 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. After installation of new equipment, 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 and free 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.

3.3 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Engineer to facilitate spot checks during testing.

3.4 INSTALLATION TOLERANCES

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

3.5 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.
- F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities at site altitude.
- 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.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.03 inches positive static pressure.

3.7 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Air Cooled Refrigerant Condensers.
 - 2. Packaged Roof Top Heating/Cooling Units.
 - 3. Packaged Terminal Air Conditioning Units.
 - 4. Unit Air Conditioners.
 - 5. Computer Room Air Conditioning Units.
 - 6. Air Coils.
 - 7. Unit Ventilators.
 - 8. Fan Coil Units.
 - 9. Air Handling Units.
 - 10. Fans.
 - 11. Air Filters.
 - 12. Air Terminal Units.
 - 13. Air Inlets and Outlets.
 - 14. Duct Smoke Detectors.
- 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. 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
8. 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
- 9. 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
- 10. 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
- 11. 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
- 12. 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
- 13. Duct Smoke Detector Test Sheet:
 - a. Duct smoke detector tested
 - b. Test results for proper operation

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. HVAC piping insulation, jackets and accessories.
 - 2. HVAC equipment insulation, jackets and accessories.
 - 3. HVAC ductwork insulation, jackets, and accessories.
- B. Related Sections:
 - 1. Section 078400 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 099100 - Painting: Execution requirements for painting insulation jackets and covering or exposed ductwork specified by this section.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - 2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 3. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - 4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
 - 5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - 6. ASTM C450 - Standard Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments.
 - 7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - 8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - 9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
 - 10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - 11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
 - 13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 17. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
 18. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 19. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
 20. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 21. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
 22. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 23. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
 24. 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.
- C. National Fire Protection Association:
1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- D. Underwriters Laboratories Inc.:
1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 2. UL 1978 - Standard for Safety for Grease Ducts.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

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, UL 723, and NFPA 255.
- 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. Perform Work in accordance with school district and AHJ Standards.
- E. Maintain one copy copies of each document on site.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 – Administrative Requirements: Pre-installation meetings.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product Storage and Handling Requirements.
- 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 damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 50 00 – Temporary Facilities and Controls: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.

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.
 - 5. Substitutions: Section 01 60 00 – Product Requirements: Product substitution procedures.

2.2 PIPE INSULATION – ALSO INCLUDES REFRIGERANT PIPING ACCESSORIES

- A. TYPE P-6: ASTM C534, Type I, Grade 1 or 2, flexible, EPDM based closed cell elastomeric insulation, tubular. (Equal to ArmaFlex UT or Aeroflex EPDM)
 - 1. Thermal Conductivity: 0.28 at 75 degrees F.
 - 2. Maximum Service Temperature: 257 degrees F.
 - 3. Operating Temperature Range: Range: Minus 297 to 257 degrees F.

2.3 PIPE INSULATION JACKETS – INCLUDES REFRIGERANT PIPING ACCESSORIES

- A. (Exterior Use): Aluminum Pipe Jacket:
 - 1. ASTM B209
 - 2. Thickness: 0.020 inch minimum thick sheet.
 - 3. Finish: Embossed.
 - 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. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum jacket single piece construction with self adhesive closure. Thickness to match pipe insulation.
- F. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- G. Adhesives: Compatible with insulation.

2.5 DUCTWORK INSULATION

- A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
 - 1. Thermal Conductivity: 0.30 at 75 degrees F.
 - 2. Maximum Operating Temperature: 250 degrees F.
 - 3. Density: 0.75 pound per cubic foot.
 - 4. Maximum flame spread index of 25 and maximum smoke developed index not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255.
- B. TYPE D-4: ASTM C1071, Type I, flexible, glass fiber duct liner with coated air side.
 - 1. Thermal Conductivity: 0.24 at 75 degrees F.
 - 2. Density: 1.5 pound per cubic foot.
 - 3. Maximum Operating Temperature: 250 degrees F.
 - 4. Maximum Air Velocity: 6,000 feet per minute.
 - 5. Maximum flame spread index of 25 and maximum smoke developed index not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255.

2.6 DUCTWORK INSULATION JACKETS

- A. Vapor Retarder Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 - 3. Secure with pressure sensitive tape.
- B. Outdoor Duct Jacket: In addition to the specified insulation for exterior duct, the insulation shall be wrapped with one layer of Alumaguard or equal duct insulation/jacket.
 - 1. Maximum flame spread index of 25 and maximum smoke developed index not exceeding 50 in accordance with ASTM E84, UL 723, and NFPA 255.

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, with integral head.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Lagging Adhesive: Fire resistive to ASTM E84, NFPA 255, and UL 723.
- G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- H. Adhesives: Compatible with insulation.
- I. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify ductwork has been tested before applying insulation materials.
- C. 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. Seek guidance from the Architect/Engineer for penetrations of assemblies with fire resistance rating greater than one hour.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, 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.
- 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. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
 2. Miter joints at elbows.
 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 4. When application requires multiple layers, apply with joints staggered.
 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
- G. High Temperature Pipe Insulation:
1. Install in multiple layers to meet thickness scheduled.
 2. Attach each layer with bands. Secure first layer with bands before installing next layer.
 3. Stagger joints between layers.
 4. Cover with aluminum jacket at exterior locations with seams located on bottom side of horizontal piping.
- H. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. 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.

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 Conditioned Spaces: Seal duct neatly and field paint color as selected by the architect.
- 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.
- F. Duct and Plenum Liner:
1. Adhere insulation with adhesive for 100 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.
- G. Ducts Exterior to Building:
1. Install insulation according to external duct insulation paragraph above.
 2. Provide external insulation with vapor retarder jacket. Cover with one layer of Alumaguard insulation/jacket with a 1-2" overlap with seams located on bottom side of horizontal duct section.
- H. Prepare duct insulation for finish painting.

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. HVAC commissioning description.
 - 2. HVAC commissioning responsibilities.
- B. Related Sections:
 - 1. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: For requirements and procedures concerning testing, adjusting, and balancing of mechanical systems.
 - 2. Section 23 09 23 - Direct-Digital Control System for HVAC: Submittal, training, and programming requirements.
- C. The Owner has hired the Commissioning Authority. The Contractor shall perform functional performance testing of the mechanical and controls systems using the functional performance tests provided by the Commissioning Authority. The mechanical and controls contractors shall demonstrate the performance of the mechanical and controls systems to the Commissioning Authority through functional performance testing.

1.2 COMMISSIONING DESCRIPTION

- A. HVAC commissioning includes the following tasks:
 - 1. Provide qualified personnel to assist in commissioning tests.
 - 2. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
- B. Equipment and Systems to be Commissioned:
 - 1. Air handling units.
 - 2. Packaged heat pump units.
 - 3. Self-contained air conditioning units.
 - 4. Packaged terminal air conditioning units.
 - 5. Packaged terminal heat pump units.
 - 6. VRF split fan coil units.
 - 7. VRF air-source heat recovery condensing units
 - 8. Unit ventilators.
 - 9. Constant volume terminal units.
 - 10. Variable volume terminal units.
 - 11. Fans.
 - 12. Automatic temperature control system.

1.3 COMMISSIONING SUBMITTALS

- A. Draft Forms: The Commissioning Authority will create draft functional performance test checklists.
- B. Test Reports: The Commissioning Authority will record functional performance test results for each commissioned equipment and system.
- C. Field Reports: The Commissioning Authority will record deficiencies preventing completion of equipment or system functional performance tests and deficiencies preventing commissioned equipment or systems from achieving specified performance.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.

1.5 QUALITY ASSURANCE

- A. Perform Work using the guidance of ASHRAE Guideline 0-2019 and 1.1-2007.

1.6 COMMISSIONING RESPONSIBILITIES

- A. Equipment or System Installer Commissioning Responsibilities:
 - 1. Attend functional performance testing
 - 2. Ensure controls installer performs assigned commissioning responsibilities as specified below.
 - 3. Provide instructions and demonstrations for Owner's personnel.
 - 4. Ensure subcontractors perform assigned commissioning responsibilities.
 - 5. Provide personnel to assist Commissioning Authority during functional performance tests.
 - 6. 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.
 - 7. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
 - 8. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
 - 9. Conduct HVAC system orientation and inspection.
- B. Controls Installer Commissioning Responsibilities:
 - 1. Attend functional performance testing
 - 2. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
 - 3. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and Architect/Engineer.

4. Inspect, check, and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
5. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application
6. Demonstrate system performance and operation to Commissioning Authority during functional performance tests, including each mode of operation.
7. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
8. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.
- B. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.
- C. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements (should line up with test holes already made by TAB).
- D. Prior to start of functional performance test, install new filters in equipment.

END OF SECTION

SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes control equipment and software.
- B. Related Sections:
 - 1. Section 26 05 33 – Raceways and Boxes for Electrical Systems.
- C. Controls contractor shall work directly for the General Contractor.

1.2 REFERENCES

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

1.3 SYSTEM DESCRIPTION

- A. Automatic temperature controls field monitoring and control system using field programmable microprocessor-based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Provide computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Provide control systems consisting of thermostats, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.
- E. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. 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.
 7. Coordinate submittals with information requested on drawings and other specifications.
- C. Product Data: Submit data for each system component and software module.
- D. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Closeout Requirements: Closeout procedures.
- B. 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.
- C. 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: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 – Administrative Requirements: Pre-installation meetings.
- B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer warranty for direct digital controls.

1.10 MAINTENANCE SERVICE

- A. Section 01 70 00 – Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of control systems for one year from Date of Substantial Completion.
- C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.
- 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. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- G. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.
- H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.11 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 DIRECT DIGITAL CONTROLS

- A. Furnish a complete system with BACnet ability that has a visual display and is connected to the owner's existing controls system.

2.2 CONTROL UNITS

- A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.
- B. Controller shall have a memory needed to ensure high performance and data reliability. Battery shall provide power for orderly shutdown of controller and storage of data in nonvolatile flash memory. Battery backup shall maintain real-time clock functions for a minimum of 20 days.
- C. Control Units Functions:
 - 1. Monitor or control each input/output point.
 - 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 - 3. Acquire, process, and transfer information to operator station or other control units on network.
 - 4. Accept, process, and execute commands from other control unit's or devices or operator stations.
 - 5. Access both data base and control functions simultaneously.
 - 6. Record, evaluate, and report changes of state or value occurring among associated points. Continue to perform associated control functions regardless of status of network.
 - 7. Perform in stand-alone mode:
 - a. Start/stop.
 - b. Duty cycling.
 - c. Automatic Temperature Control.
 - d. Demand control via a sliding window, predictive algorithm.
 - e. Event initiated control.
 - f. Calculated point.
 - g. Scanning and alarm processing.
 - h. Full direct digital control.
 - i. Trend logging.
 - j. Global communications.
 - k. Maintenance scheduling.
- D. Global Communications:
 - 1. Broadcast point data onto network, making information available to other system controls units.
 - 2. Transmit input/output points onto network for use by other control units and use data from other control units.
- E. Input/output Capability:

1. Discrete/digital input (contact status).
 2. Discrete/digital output.
 3. Analog input.
 4. Analog output.
 5. Pulse input (5 pulses/second).
 6. Pulse output (0-655 seconds in duration with 0.01-second resolution).
- F. Monitor, control, or address data points. Include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs. Furnish control units with minimum 25 percent spare capacity.
- G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.
- H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard-wired LAN or 60 seconds over voice grade phone lines.
- I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from workstation.
 2. Control output points but change only database state or value; leave external field hardware unchanged.
 3. Enable control-actions on output points but change only data base state or value.
- J. Local display and adjustment panel: Separate or Integral to control-unit containing digital display, and numerical keyboard. Display and adjust:
1. Input/output point information and status.
 2. Controller set points.
 3. Controller tuning constants.
 4. Program execution times.
 5. High and low limit values.
 6. Limit differential.
 7. Set/display date and time.
 8. Control outputs connected to the network.
 9. Automatic control outputs.
 10. Perform control unit diagnostic testing.
- K. Points in "Test" mode.

2.3 LOCAL AREA NETWORKS (LAN):

- A. Furnish communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.

- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, less than 3 seconds. Furnish automatic reconfiguration when station is added or lost. In event transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.4 OPERATING SYSTEM SOFTWARE

- A. Input/Output Capability from Operator Station:
 - 1. Request display of current values or status in tabular or graphic format.
 - 2. Command selected equipment to specified state.
 - 3. Initiate logs and reports.
 - 4. Change analog limits.
 - 5. Add, delete, or change points within each control unit or application routine.
 - 6. Change point input/output descriptors, status, alarm descriptors, and unit descriptors.
 - 7. Add new control units to system.
 - 8. Modify and set up maintenance scheduling parameters.
 - 9. Develop, modify, delete or display full range of color graphic displays.
 - 10. Automatically archive select data even when running third party software.
 - 11. Capability to sort and extract data from archived files and to generate custom reports.
 - 12. Support two printer operations.
 - 13. Alarm printer: Print alarms, operator acknowledgments, action messages, system alarms, operator sign-on and sign-off.
 - 14. Data printer: Print reports, page prints, and data base prints.
 - 15. Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
 - 16. Print selected control unit database.
- B. Data Base Creation and Support: Use standard procedures for changes. Control unit automatically checks workstation data base files upon connection and verify data base match. Include the following minimum capabilities:
 - 1. Add and delete points.
 - 2. Modify point parameters.
 - 3. Change, add, or delete English language descriptors.
 - 4. Add, modify, or delete alarm limits.
 - 5. Add, modify, or delete points in start/stop programs, trend logs, and other items.
 - 6. Create custom relationship between points.

7. Create or modify DDC loops and parameters.
 8. Create or modify override parameters.
 9. Add, modify, and delete applications programs.
 10. Add, delete, develop, or modify dynamic color graphic displays.
- C. Dynamic Color Graphic Displays:
1. Utilizes custom symbols or system supported library of symbols.
 2. Sixteen (16) colors.
 3. Sixty (60) outputs of real-time live dynamic data for each graphic.
 4. Dynamic graphic data.
 5. 1,000 separate graphic pages.
 6. Modify graphic screen refresh rate between 1 and 60 seconds.
- D. Operator Station:
1. Accept data from LAN as needed without scanning entire network for updated point data.
 2. Interrogate LAN for updated point data when requested.
 3. Allow operator command of devices.
 4. Allow operator to place specific control units in or out of service.
 5. Allow parameter editing of control units.
 6. Store duplicate data base for every control unit and allow down loading while system is on line.
 7. Control or modify specific programs.
 8. Develop, store and modify dynamic color graphics.
 9. Data archiving of assigned points and support overlay graphing of this data using up to four (4) variables.
- E. Alarm Processing:
1. Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state or value and alarms causing automatic dial-out.
 2. Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
 3. Print on line changeable message, up to 60 characters in length, for each alarm point specified.
 4. Display alarm reports on video. Display multiple alarms in order of occurrence.
 5. Define time delay for equipment start-up or shutdown.
 6. Allow unique routing of specific alarms.
 7. Operator specifies when alarm requires acknowledgment.
 8. Continue to indicate unacknowledged alarms after return to normal.
 9. Alarm notification:
 10. Print automatically.
 11. Display indicating alarm condition.
 12. Selectable audible alarm indication.
- F. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change of state, specified state, or alarm occurrence or return to normal.

- G. Automatic Restart: Automatically start field equipment on restoration of power. Furnish time delay between individual equipment restart and time of day start/stop.
- H. Messages:
 - 1. Automatically display or print user-defined message subsequent to occurrence of selected events.
 - 2. Compose, change, or delete message.
 - 3. Display or log message at any time.
 - 4. Assign any message to event.
- I. Reports:
 - 1. Manually requested with time and date.
 - 2. Long term data archiving to hard disk.
 - 3. Automatic directives to download to transportable media including floppy diskettes for storage.
 - 4. Data selection methods to include data base search and manipulation.
 - 5. Data extraction with mathematical manipulation.
 - 6. Data reports to allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
 - 7. Generating reports either normally at operator direction, or automatically under workstation direction.
 - 8. Either manually display or print reports. Automatically print reports on daily, weekly, monthly, yearly or scheduled basis.
 - 9. Include capability for statistical data manipulation and extraction.
 - 10. Capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.
- J. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.
- K. Data Collection:
 - 1. Automatically collect and store in disk files.
 - 2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2-year period.
 - 3. Daily consumption for up to 30 meters over a 2-year period.
 - 4. Daily billable electrical energy consumption and time for up to 1024 zones over a 10-year period.
 - 5. Archiving of stored data for use with system supplied custom reports.
- L. Graphic Display: Support graphic development on work station with software features:
 - 1. Page linking.
 - 2. Generate, store, and retrieve library symbols.
 - 3. Single or double height characters.
 - 4. Sixty (60) dynamic points of data for each graphic page.
 - 5. Pixel level resolution.
 - 6. Animated graphics for discrete points.
 - 7. Analog bar graphs.
 - 8. Display real time value of each input or output line diagram fashion.

- M. Maintenance Management:
 - 1. Run time monitoring, for each point.
 - 2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
 - 3. Equipment safety targets.
 - 4. Display of maintenance material and estimated labor.
 - 5. Target point reset, for each point.
- N. Advisories:
 - 1. Summary containing status of points in locked out condition.
 - 2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
 - 3. Report of power failure detection, time and date.
 - 4. Report of communication failure with operator device, field interface unit, point and programmable control unit.

2.5 LOAD CONTROL PROGRAMS

- A. General: Support inch-pound units of measurement.
- B. Demand Limiting:
 - 1. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
 - 2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
 - 3. Forecast demand (kW): Predicted by sliding window method.
 - 4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
 - 5. Demand Target: Minimum of 3 for each demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
 - 6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
 - 7. Limits: Include control band (upper and lower limits).
 - 8. Output advisory when loads are not available to satisfy required shed quantity, advise shed requirements and requiring operator acknowledgment.
- C. Duty Cycling:
 - 1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
 - 2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by equal quantity off portion is reduced.
 - 3. Set and modify following parameters for each individual load.
 - a. Minimum and maximum off time.
 - b. On/Off time in one-minute increments.
 - c. Time period from beginning of interval until cycling of load.
 - d. Manually override the DDC program and place a load in an On or Off state.

- e. Cooling Target Temperature and Differential.
 - f. Heating Target Temperature and Differential.
 - g. Cycle off adjustment.
- D. Automatic Time Scheduling:
 - 1. Self-contained programs for automatic start/stop/scheduling of building loads.
 - 2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
 - 3. Special day's schedule supporting up to 30 unique date/duration combinations.
 - 4. Number of loads assigned to time program; with each load having individual time program.
 - 5. Each load assigned at least 16 control actions for each day with 1 minute resolution.
 - 6. Furnish the following time schedule operations:
 - a. Start.
 - b. Optimized Start.
 - c. Stop.
 - d. Optimized Stop.
 - e. Cycle.
 - f. Optimized Cycle.
 - 7. Capable of specifying minimum of 30 holiday periods up to 100 days in length for the year.
 - 8. Create temporary schedules.
 - 9. Broadcast temporary "special day" date and duration.
- E. Start/Stop Time Optimization:
 - 1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
 - 2. Adaptive and self-tuning, adjusting to changing conditions unattended.
 - 3. For each point under control, establish and modify:
 - a. Occupancy period.
 - b. Desired temperature at beginning of occupancy period.
 - c. Desired temperature at end of occupancy period.
- F. Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set-point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.
- G. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.
 - 1. Employ arithmetic, algebraic, Boolean, and special function operations.
 - 2. Treat calculated values like any other analog value; use for any function where a "hard wired point" might be used.
- H. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.
 - 1. Define time interval between each control action between 0 to 3600 seconds.
 - 2. Output may be analog value.
 - 3. Provide for "skip" logic.

4. Verify completion of one action before proceeding to next action. When not verified, program capable of skipping to next action.
- I. Direct Digital Control: Furnish with each control unit Direct Digital Control software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
 1. Control loops: Defined using "modules" are analogous to standard control devices.
 2. Output: Paired or individual digital outputs for pulse width modulation, and analog outputs.
 3. Firmware:
 - a. PID with analog or pulse-width modulation output.
 - b. Floating control with pulse-width modulated outputs.
 - c. Two-position control.
 - d. Primary and secondary reset schedule selector.
 - e. Hi/Low signal selector.
 - f. Single pole double-throw relay.
 - g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
 4. Direct Digital Control loop: Downloaded upon creation or on operator request. On sensor failure, program executes user defined failsafe output.
 5. Display: Value or state of each of lines interconnecting DDC modules.
- J. Fine Tuning Direct Digital Control PID or floating loops:
 1. Display information:
 - a. Control loop being tuned.
 - b. Input (process) variable.
 - c. Output (control) variable.
 - d. Set-point of loop.
 - e. Proportional band.
 - f. Integral (reset) Interval.
 - g. Derivative (rate) Interval.
 2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" versus "variable".
- K. Trend logging:
 1. Each control unit capable of storing samples of control unit's data points.
 2. Update file continuously at operator assigned intervals.
 3. Automatically initiate upload requests and then stores data on hard disk.
 4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
 5. Co-ordinate sampling with specified on/off point- state.
 6. Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

2.6 HVAC CONTROL PROGRAMS

- A. General:
 1. Support Inch-pound units of measurement.

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, both hot deck and cold deck temperatures on dual duct and multizone systems, 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.
- D. Enthalpy Switchover:
- 1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
 - 2. Operator commands:
 - a. Add/delete fan status point.
 - b. Add/delete outside air temperature point.

- c. Add/delete discharge controller point.
- d. Define discharge controller parameters.
- e. Add/delete return air temperature point.
- f. Add/delete outside air dewpoint/humidity point.
- g. Add/delete return air dewpoint/humidity point.
- h. Add/delete damper switch.
- i. Add/delete minimum outside air.
- j. Add/delete atmospheric pressure.
- k. Add/delete heating override switch.
- l. Add/delete evaporative cooling switch.
- m. Add/delete air flow rate.
- n. Define enthalpy deadband.
- o. Lock/unlock program.
- p. Request control summary.
- q. Request HVAC point summary.
- 3. Control summary:
 - a. HVAC control system begin/end status.
 - b. Enthalpy switchover optimal system status.
 - c. Optimal return time system status.
 - d. Current outside air enthalpy.
 - e. Calculated mixed air enthalpy.
 - f. Calculated cooling coil enthalpy using outside air.
 - g. Calculated cooling coil enthalpy using mixed air.
 - h. Calculated enthalpy difference.
 - i. Enthalpy switchover deadband.
 - j. Status of damper mode switch.

2.7 PROGRAMMING APPLICATION FEATURES

- A. Trend Point:
 - 1. Sample up to 20 points, real or computed, with each point capable of collecting 20 samples at intervals specified in minutes, hours, days, or month.
 - 2. 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 or 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. Allow definition of minimum of 100 messages, each having minimum length of 60 characters for each individual message.
 - 2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totaled point's warning limit, hardware elements advisories.
 - 3. Output assigned alarm with "message requiring acknowledgment".
 - 4. 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. Section 01 30 00 – Administrative Requirements: Coordination and project conditions.
- B. Verify conditioned power supply is available to control units and to operator workstation.

- C. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where they will not be subject to excessive vibration.
- B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operation. Refer to Drawings.
- C. Install with 120 volts alternating current, 15-amp dedicated emergency power circuit to each programmable control unit.
- D. Install conduit and electrical wiring in accordance with Section 26 05 33 – Raceways and Boxes for Electrical Systems.
- E. Install electrical material and installation in accordance with appropriate requirements of 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. Furnish service technician employed by system installer to instruct Owner's representative in operation of the equipment.

3.4 DEMONSTRATION AND TRAINING

- A. Section 01 70 00 – Execution and Closeout Requirements: Demonstration and instructions.
- B. Furnish basic operator training for 2 persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 8 hours instructor time. Furnish training on site.
- C. Demonstrate complete and operating system to Owner.

3.5 SCHEDULES

- A. See controls diagrams on drawings.

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. Pipe hangers and supports.
 - 4. Valves.
- B. Related Sections:
 - 1. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.

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.
 2. AWS D1.1 - Structural Welding Code - Steel.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. Underwriters Laboratories Inc.:
 1. UL 429 - Electrically Operated Valves.

1.3 SYSTEM DESCRIPTION

- A. The refrigerant piping system shall be constructed using field provided ACR copper rated for the use with refrigerant R410A, de-hydrated pipe field engineered and assembled with manufacturer supplied Heat recovery unit(s) and Y- branches, as may be required, connected to multiple indoor units to effectively and efficiently control the heat pump operation or simultaneous heating and cooling operation of the heat recovery VRF system. NOTE: SHOULD THE REFRIGERANT IN THE SYSTEM CHANGE, PROVIDE PIPING SYSTEM FOR SYSTEM REFRIGERANT PER MANUFACTURER'S INSTRUCTIONS.
- B. 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.
- C. 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.
- D. Provide pipe hangers and supports in accordance with ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- C. 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. Hangers and Supports: Submit manufacturers catalog information including load capacity.
- D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of refrigerant leak test and piping system pressure test.
- F. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- G. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- H. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.
- C. 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.
- B. Perform Work in accordance with applicable code, authority having jurisdiction, and AWS D1.1 for welding hanger and support attachments to building structure.
- C. Perform Work in accordance with Yuma County standards.
- D. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.
- C. Design piping system, hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 – Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product Storage and Handling Requirements.
- B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
- C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 50 00 – Temporary Facilities and Controls: Environmental conditions affecting products on site.
- B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 COORDINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and Project Conditions.

1.13 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for valves excluding packing.

1.14 MAINTENANCE MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.

1.15 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two packing kits for each size and valve type.

PART 2 PRODUCTS

2.1 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, Type ACR hard drawn. Seamless Phosphorous Deoxidized, minimum wall thickness for R410A application. System shall be marked “R410 RATED” and must be approved for a maximum operating pressure of 551 psi.
 - 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 PIPE HANGERS AND SUPPORTS

- A. Furnish materials in accordance with city and school district standards.
- B. Conform to ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- C. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
- D. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
- E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- F. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

- I. Floor Support for Hot Pipe 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- J. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.
- K. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- L. 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 VALVES

- A. Manufacturers:
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Co. Model.
 - 4. Substitutions: Permitted.
- B. Ball Valves:
 - 1. Two piece forged brass body with dual teflon ball seals and copper tube extensions, full port, brass seal cap, chrome plated ball, stem with neoprene ring stem seals, flare and ODS connections or brazed ends. To be rated for system refrigerant type.
 - 2. Maximum working pressure: 500 psig.
 - 3. Maximum working temperature: 300 degrees F.
- C. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends.
 - 2. Maximum working pressure: 500 psig.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Coordination and Project Conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Fully install piping per VRF and mini split system manufacturer's requirements and recommendations.
- B. Ream pipe and tube ends. Remove burrs.
- C. Remove scale and dirt on inside and outside before assembly.

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

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.5, ASTM F708, and MSS SP 89.
- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every [other] floor. Support riser piping independently of connected horizontal piping.
- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Provide copper plated hangers and supports for copper piping.
- I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install piping to conserve building space, and not interfere with use of space.
- B. Install pipe identification in accordance with Section 23 05 00.
- C. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Provide expansion loops at locations and sizes as recommended by equipment manufacturer.
- D. Provide access where valves and fittings are not exposed.
- E. Arrange refrigerant piping to return oil to compressor, per manufacturer's instructions.
- F. Flood refrigerant piping system with nitrogen when brazing.
- G. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 90 00.

- H. Install valves with stems upright or horizontal, not inverted.
- I. Insulate piping; refer to Section 23 07 00.
- J. Fully charge completed system with refrigerant after testing.
- K. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- L. Install refrigerant piping in accordance with ASME B31.5.

3.5 FIELD QUALITY CONTROL

- A. Section 01 45 24 – Testing and Inspection Requirements for School Construction: Field inspecting, testing, adjusting, and balancing.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test refrigeration system with dry nitrogen to 200 psig or as recommended by equipment manufacturer.
- D. Repair leaks.
- E. Retest until no leaks are detected.

3.6 SCHEDULES

- A. Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	MINIMUM HANGER ROD DIAMETER COPPER TUBING Inches
1/2	5	3/8
3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8

END OF SECTION

SECTION 23 30 00

HVAC AIR DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ductwork.
 - 2. Ductwork accessories.
 - 3. Control Dampers and Actuators.
 - 4. Fans.
 - 5. Air Outlets.
 - 6. Filters.

1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Submit sizes, capacities, materials, controls and connections to other work.
 - 2. Submit catalog performance ratings, construction, electric and duct connections, flashing and dimensions for fans and exhausters.
- C. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts lists, and wiring diagrams.
- D. Manufacturer's Installation Instructions: Submit relevant instructions.

1.3 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for filter replacement, spare parts lists, and wiring diagrams.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with Yuma County standards.
- B. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 DUCTWORK

- A. Duct Materials (less fume hood exhaust duct):
 - 1. Furnish materials in accordance with Yuma County standards.
 - 2. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G60 zinc coating of in conformance with ASTM A90/A90M.
 - 3. Fasteners: Rivets, bolts, or sheet metal screws.
 - 4. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- B. Ductwork Fabrication:
 - 1. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
 - 2. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards), and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
 - 3. 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.
 - 4. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - 5. 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.
 - 6. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.
- C. Insulated Flexible Ducts:
 - 1. Furnish materials in accordance with Yuma County standards.
 - 2. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical wound spring steel wire; fiberglass insulation; polyethylene or aluminized vapor barrier film.
 - a. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 - b. Maximum Velocity: 4000 fpm.
 - c. Temperature Range: -20 degrees F to 210 degrees F.
 - d. Thermal Resistance: 6.0 installed square feet-hour-degree F per BTU.
- D. Single Wall Spiral Round Ducts:

1. Furnish materials in accordance with Yuma County standards.
2. Product Description: UL 181, Class 1, round spiral lock seam duct constructed of galvanized steel.
3. 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

4. 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

2.2 DUCT ACCESSORIES

- A. Volume Control Dampers:
 1. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
 2. Fabricate splitter dampers of material matching duct gage to 24 inches size in each direction, and two gages heavier for larger sizes. Secure with continuous hinge or rod. Operate with minimum 1/4 inch diameter rod.
 3. Fabricate single blade dampers for duct sizes to 12 x 30 inch.
 4. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
 5. Except in round ductwork 12 inches and smaller, furnish end bearings.
 6. Furnish locking, indicating quadrant regulators on single and multi-blade dampers. Where width exceeds 30 inches, furnish regulator at both ends.
- B. Turning Devices and Extractors:
 1. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.
 2. Multi-blade device with radius blades attached to pivoting frame and bracket, steel or aluminum construction, with push-pull operator strap.

- C. Flexible Duct Connections:
 - 1. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, approximately 3 inches wide, crimped into metal edging strip.
- D. Duct Access Doors:
 - 1. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Doors shall be low leakage and insulated type.
 - 2. Access doors smaller than 12 inches square secured with sash locks. Access doors with sheet metal screw fasteners are not acceptable.
- E. Back-draft Dampers:
 - 1. Furnish materials in accordance with Yuma County standards.
 - 2. Gravity back-draft dampers size 18 x 18 inches or smaller, furnished with air moving equipment, furnish of air moving equipment manufacturers standard construction.
 - 3. Fabricate multi-blade, parallel action gravity balanced back-draft dampers of galvanized steel, or extruded aluminum, with center pivoted blades, with sealed edges, linked together, steel ball bearings, and plated steel pivot pin.

2.3 CONTROL DAMPERS AND ACTUATORS

- A. CONTROL AIR DAMPERS
 - 1. Furnish materials in accordance with Yuma County standards.
 - 2. Performance: Test in accordance with AMCA 500.
 - 3. Frames: Galvanized steel, extruded aluminum, rolled carbon steel, or stainless steel, welded or riveted with corner reinforcement, minimum 12 gage.
 - 4. Blades: Galvanized steel, extruded aluminum, rolled carbon steel, or stainless steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, attached to minimum 1/2 inch shafts with set screws.
 - 5. Blade Seals: Synthetic elastomeric or neoprene mechanically attached, field replaceable.
 - 6. Jamb Seals: Stainless steel spring.
 - 7. Shaft Bearings: Oil impregnated sintered bronze or graphite impregnated nylon sleeve, with thrust washers at bearings.
 - 8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
 - 9. Outside Air Damper Leakage: Maximum leakage rate of 3.0 cfm per square foot at 1.0 inch wg pressure differential.
 - 10. Damper Leakage: Less than one percent based on approach velocity of 2000 fpm and 4 inches wg.
 - 11. Maximum Pressure Differential: 6 inches wg.
 - 12. Temperature Limits: - 40 to 200 degrees F.
- B. ELECTRIC DAMPER ACTUATORS
 - 1. Furnish materials in accordance with Yuma County standards.
 - 2. Operation: Two-position, reversing type proportional motor, and/or spring-return, as required on drawings.
 - 3. Enclosure Rating: NEMA 250 Type 1, 3, or 4, as appropriate for the installation location.

4. Mounting: Direct mount.
5. Stroke: 90 seconds end to end full stroke, 15 seconds return to normal for spring return.
6. Protection: Electronic stall protection.
7. Control Input: 0-10 VDC or 0-20 mA DC.
8. Power: Nominal 24 or 120 volt AC.
9. Torque: Size for minimum 150 percent of required duty.
10. Duty cycle: rated for 65,000 cycles.
11. Accessories:
 - a. Cover mounted transformer.
 - b. Auxiliary potentiometer.
 - c. Damper linkage.
 - d. Direct drive feedback potentiometer.
 - e. Output position feedback.
 - f. Field selectable rotational, spring return direction, field adjustable zero and span.
 - g. End switch.

2.4 FANS

- A. Downblast Centrifugal Roof Fans:
 1. Manufacturers:
 - a. Greenheck Corp.
 - b. Substitutions: Section 01 60 00 – Product Requirements: Product substitution procedures.
 2. Furnish materials in accordance with Yuma County standards.
 3. Fan Unit: Downblast type. Direct drive, with spun aluminum housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets. Backward inclined centrifugal wheel constructed of aluminum, statically and dynamically balanced in accordance to AMCA Standard 204-05.
 4. Electronically Commutated Motor: Open type, DC electronic commutation type motor specifically designed for fan applications. Permanently lubricated, heavy duty ball bearing type to match with the fan and pre-wired to the specific voltage and phase. Controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal. Minimum 85% efficient at all speeds.
 5. Roof Curb Adapter: Galvanized steel construction with continuously welded seams.

2.5 AIR OUTLETS AND INLETS

- A. Manufacturers:
 1. Price.
 2. Titus.
 3. Krueger.
 4. Nailor.
 5. Substitutions: Section 01 60 00 – Product Requirements: Product substitution procedures.

- B. Ceiling Diffusers: Square or Rectangular, stamped or spun, multi-core type diffuser to discharge air in 360-degree pattern, with sectoring baffles where indicated; factory finish with color as selected by the architect.
- C. Registers: Streamlined and individually adjustable blades, deflection as indicated on drawings, dampers where indicated on drawings; with factory finish with color as selected by the architect.
- D. Grilles: Heavy extruded aluminum border and $\frac{1}{2}$ " x $\frac{1}{2}$ " x $\frac{1}{2}$ " aluminum core, or angled blades at $\frac{3}{4}$ " spacing, type per plans schedules. Grille face full size of ceiling tile, in lay-in applications. Dampers where indicated on drawings, either through manual volume dampers in ductwork (where able to be accessed), or opposed blade dampers in grilles where MVD's are not accessible. Factory finish with color as selected by architect.

2.6 FILTERS

- A. Furnish materials in accordance with Yuma County standards.
- B. Disposable, Extended Area Panel Filters: Pleated, reinforced cotton or glass fiber fabric; supported and bonded to welded wire grid.
 - 1. Nominal size: as listed on drawings or per equipment sizes.
 - 2. Nominal thickness: as listed on drawings.
 - 3. Performance Rating: as listed on drawings..

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify sizes of equipment connections before fabricating transitions.
- B. Verify rated walls are ready for fire damper installation.
- C. Verify ducts and equipment installation are ready for accessories.
- D. 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. Metal Ducts: Install in accordance with SMACNA Duct Construction Standards - Metal and Flexible.
- B. Connect flexible ducts to metal ducts with two well spaced draw bands over ductwork connection and tow well spaced draw bands over insulation connection.
- C. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of airflow.

- D. Fiberglass Ducts: Install in accordance with SMACNA Fibrous Glass Duct Construction Standards.
- E. Install flexible connections immediately adjacent to fans and motorized equipment. Install flexible connections specified between fan inlet and discharge ductwork. Prevent flexible connectors being in tension while running.
- F. Install back-draft dampers on discharge of exhaust fans and as indicated on Drawings.
- G. Prevent passage of unfiltered air around filters by installing felt, rubber, or neoprene gaskets.
- H. Install filter gage static pressure tips upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level.
- I. Cut openings in ductwork to accommodate thermometers and controllers. Cut pitot tube openings for testing of systems, complete with metal can with spring device or screw to eliminate against air leakage.
- J. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- K. Connect diffusers boots to low pressure ducts with 5 feet maximum length of flexible duct. Hold in place with strap or clamp.
- L. At installer's option, fiberglass ductwork may be substituted for internally or externally insulated or non-insulated low-pressure sheet metal ductwork.
- M. During construction install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- N. Access Doors: Install access doors at the following locations and as indicated on Drawings:
 - 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 fan.
 - 5. Before and after each automatic control damper.
- O. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated on Drawings. Install 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- P. Support terminal units individually from structure. Do not support from adjacent ductwork. Install with minimum of 5 ft of 2-inch-thick lined ductwork downstream of units.

- Q. Install balancing dampers on duct take-off to diffusers and grilles and registers, regardless of whether dampers are specified as part of diffuser, or grille and register assembly.
- R. Paint ductwork visible behind air outlets and inlets matte black.
- S. Do not operate fans until ductwork is clean, filters are in place, bearings lubricated, and fan has been test-run under observation.
- T. Install fans with resilient mountings and flexible electrical leads.
- U. Install sheaves required for final air balance.
- V. Install safety screen where fan inlet or outlet is exposed.
- W. Install fans with access to adjustable blade axial fan wheels for varying blade angle setting. Adjust blades for varying range of volume and pressure.

3.3 SCHEDULES

- A. See drawings.

END OF SECTION

SECTION 23 74 13

VRF SPLIT FAN COIL UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes VRF factory air-handling units and accessories.
- B. System Description:
 - 1. Indoor, direct-expansion concealed duct units or wall mounted units are matched with a heat pump or a heat recovery VRF (variable refrigerant flow) outdoor unit.

1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data, Submit the following:
 - 1. For each type include the following:
 - a. Complete fan performance curves for Supply Air.
 - b. Sound performance data for Supply Air.
 - c. Motor ratings, electrical characteristics, motor and fan accessories.
 - d. Performance ratings for all coils.
 - e. Dimensioned drawings for each type of installation to include location of attached ductwork and service clearance requirements.
 - f. Estimated gross weight of each installed unit.
 - g. Installation, Operation and Maintenance manual (IOM) for each model.
 - h. Microprocessor Controller specifications to include available options and operating modes. They must be compatible with LG AC Smart Controller.
- C. Manufacturer's Installation Instructions.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Certification of Factory Training: The installing contractor shall provide certification that they have taken the VRF manufacturer's installation courses. The on-site installation personnel shall have taken and passed this course.

1.3 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.4 QUALITY ASSURANCE

- A. Section 01 40 00 – Quality Requirements.
- B. Unit shall be Engineering Testing Laboratory (ETL) listed and certified to UL 60335-2-40 3rd edition standard.
- C. Perform Work in accordance with Yuma County standards.
- D. Maintain one copy of each document on site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product Storage and Handling Requirements.
- B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.6 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for units.

1.7 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish one set of filters for each unit.

PART 2 PRODUCTS

2.1 FAN COIL UNITS

- A. Manufacturers:
 - 1. Carrier Toshiba
 - 2. Trane Mitsubishi
 - 3. Lennox International
 - 4. LG
 - 5. Substitutions: Section 01 60 00 – Product Requirements: Product substitution procedures.
- B. General: Indoor, direct-expansion ducted fan coil. Unit shall be complete with a coil, fan driven by DC inverter motor, PMV (pulse modulating valve), piping connectors,

electrical controls, microprocessor control system, integral temperature sensing, condensate lift mechanism with a lift capability of 24.3in, and hanging brackets.

- C. Unit Cabinet: Constructed of zinc-coated steel. The unit shall be capable of being configured for either bottom or rear return. The cabinet shall have a knockout for fresh air intake.
- D. Fans: Multi-blade type with its performance designed to match the coil performance. The fan shall be statically and dynamically balanced to ensure low noise and vibration and capable of up to 0.8in. wg external static pressure (medium static ducted units) or 1.0in. wg external static pressure (high static ducted units).
- E. Coil: Copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion and specially coated for enhanced wettability. A drip pan under the coil shall have a factory-installed condensate lift mechanism with a lift capacity of 24.3" and drain connection for hose attachment to remove condensate.
- F. Motors: Totally enclosed, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be inverter controlled variable speed.
- G. Controls: Microprocessor-controlled to maintain precise room temperature and minimum power consumption. The controls system shall employ a genetic algorithm for temperature control.
 - 1. Any of the following user interface accessories shall be compatible with the unit.
 - a. Wired Remote Controller: Shall communicate over two-core shielded wire up to 1640 ft. It shall be capable of controlling groups of up to 8 indoor units. It shall be able to operate as a primary or secondary controller when two remote controllers are connected to a single indoor unit or group. The system shall be able to be configured so that the return air (TA) can be sensed at the unit, at the remote controller or through a remote sensor. The local controller shall minimally be able to control On-OFF, set point, mode, and be able to display system generated error codes.
 - b. Central Controller: Shall communicate over two-core shielded wire up to 6500 ft and use existing indoor – outdoor communication protocol to communicate. A single central controller shall be capable of controlling up to 256 indoor units individually with capability to program multiple schedules. It shall be able to create 2 indoor unit line-ups with 128 units on each line. It shall provide weekly, special day and operational scheduling feature. During schedule operation, user can set the power status (ON/OFF), operation mode, temperature setup, and remote-control operation, restricted / allowed, return back and ventilation operation. It shall provide a web interface for remote monitoring, control, and scheduling. It shall be capable of monitoring energy consumption for each tenant and generate monthly KW usage reports. In addition, an optional digital I/O interface shall provide alarm, fire and locking signals.
 - c. Building Management Systems: The system shall be able to be controlled by BACnet protocol either directly or through an external gateway.

- i. BACnet shall be able to control:
 - 1. ON / OFF
 - 2. operation mode
 - 3. fan speed
 - 4. louver
 - 5. set temperature
 - 6. permit / prohibit local operation
 - ii. BACnet shall be able to monitor:
 - 1. ON / OFF
 - 2. operation mode
 - 3. fan speed
 - 4. louver
 - 5. set temperature
 - 6. permit / prohibit local operation
 - 7. room temperature
 - 8. error status
 - 9. error code
- H. The unit shall have the following functions as a minimum:
 - 1. Selectable automatic restart. After power failure the system will restart at the same operating conditions as before the failure.
 - 2. Temperature-sensing controls shall sense return air temperature at the unit or at the remote control
 - 3. Indoor coil freeze protection in both cooling and heating (reversing valve failure) modes.
 - 4. Dehumidification (Dry) mode shall provide increased latent removal through total system modulation.
 - 5. Fan-only operation to provide room air circulation when no cooling is required.
 - 6. Fan speed control shall be user-selectable: high, medium, low, or microprocessor determined (Auto) based on the differential between the room temperature and the set point during all modes of operations.
 - 7. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature in heating.
 - 8. Cold blow prevention in heating.
 - 9. Adjustable compensation for air stratification in heating.
- I. Filters: The unit shall be supplied with filter in filter grilles per plans.
- J. Electrical Requirements: See plans.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM
- B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.

- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.2 PREPARATION & COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.
- B. Coordinate location of water system fittings to ensure correct positioning for condensate drain pipe.
- C. Coordinate sequencing of construction of associated plumbing, HVAC, electrical supply and sheet metal contractor.

3.3 INSTALLATION

- A. Install in accordance with ARI 430.
- B. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
- C. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.
- D. Piping installation requirements are specified on plans and in specifications, as well as by manufacturer. Provide and install piping and fittings per manufacturer requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- E. 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. Refer to Section 23 30 00.
- F. Install condensate piping with trap and route from drain pan to location on plumbing plans.

3.4 FIELD QUALITY CONTROL

- A. Furnish services of factory trained representative to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.
- B. Furnish manufacturers startup technician to startup all VRF systems; provide manufacturer's start-up forms for review and records.
- C. Vacuum clean coils and inside of unit cabinet.
- D. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.
- E. Demonstrate unit operation and maintenance.

- F. Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections.
- G. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.
- H. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 23 81 43

VRF AIR-SOURCE HEAT RECOVERY CONDENSING UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. VRF air-source heat pump heat recovery condensing units.
- B. System Description:
 - 1. The heat recovery variable refrigerant flow system is a three-pipe system consisting of a single or multiple outdoor units, multiple indoor units of various types and capacities, and multiple flow selector boxes, individual or central indoor unit controls with on/off temperature settings, all connected by fully insulated refrigerant lines utilizing factory-supplied, fully insulated branching kits. Indoor units are connected to condensate piping that shall be terminated to the nearest drain point.
 - 2. The system shall be fully capable of simultaneous heating and cooling operation as requested by the individual indoor zones that can consist of single or multiple indoor units.

1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit unit capacities. Submit water, drain, electrical, and refrigeration rough-in connections. Include physical dimensions and loading.
- C. Manufacturer's Installation Instructions: Submit relevant instructions.
- D. Certification of Factory Training: The installing contractor shall provide certification that they have taken the VRF manufacturer's installation courses. The on-site installation personnel shall have taken and passed this course.

1.3 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit maintenance recommendations and spare parts lists.

1.4 QUALITY ASSURANCE

- A. Section 01 40 00 – Quality Requirements.
- B. Air Cooled Equipment:

1. Cooling Performance Requirements: Conform to IEER / EER as scheduled.
 2. Heating Performance Requirements: Conform to minimum HSPF or COP / SCHE as scheduled.
 3. Units shall be listed by ETL (Engineering Testing Laboratory) and be evaluated in accordance with UL standard 60335-2-40, 3rd. edition.
 4. Units shall be listed in the AHRI directory.
 5. All units shall meet the Federal minimum efficiency standards and be tested per AHRI 1230 Standard.
- C. Maintain one copy of each document on site.
- D. Scheduled performance is based on ARI 210/240 test conditions.

1.5 WARRANTY

- A. Extended warranty: The Standard Warranty Period and the Compressor Warranty Period are extended to a total of ten (10) years (the "Extended Warranty Period") for qualified Systems that have been commissioned by a party that has completed the current Training Requirements. The contractor shall meet the above requirements to provide the listed warranty.

1.6 MAINTENANCE SERVICE

- A. Furnish initial start-up and shutdown during first year of operation.

PART 2 PRODUCTS

2.1 CONDENSING UNITS

- A. Manufacturers:
1. Carrier Toshiba
 2. Trane Mitsubishi
 3. Lennox International
 4. LG
 5. Substitutions: Section 01 60 00 – Product Requirements: Product substitution procedures.
- B. General: Factory-assembled, single-piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the multiple inverter-driven twin rotary compressors.
1. The maximum sound pressure rating for a single module shall not exceed 66.5 dBA sound pressure in cooling and 67.0 dBA in heating. For twinned systems the sound pressure level shall not exceed 69.5 dBA and 70.0 dBA. For 3-module systems the sound pressure level shall not exceed 71.5 dBA and 71.5 dBA. Sound pressure ratings are measured at a distance of 3.28 ft out and 4.92 ft up from the side of the outdoor unit.
 2. The outdoor unit shall include an oversized accumulator and a liquid tank for proper heating performance while allowing the indoor unit PMV (pulse

modulating valve) metering device to shut off completely when a zone is satisfied.

3. The outdoor unit shall be protected by a high-pressure switch, high-pressure sensor, low-pressure sensor, fusible plug, PC board, and an inverter overload protector.
4. The outdoor unit shall be capable of operating in cooling mode down to 14 F dry bulb ambient air temperature and down to -13 F wet bulb ambient air temperature in heating. For simultaneous heating and cooling the unit shall be capable of operating between 14 F and 60 F ambient air temperature.
5. The outdoor unit shall include a total oil management system that balances oil between compressors within a module, replenishes compressor oil to the compressors in a module from the oil separator if required, and allows oil and refrigerant to move between twinned or 3-module units if required, even if one of the units is not running.

C. Unit Cabinet

1. Constructed of pre-coated steel, finished on both inside and outside.
2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressors, fan, and control components.
3. Compressors shall be isolated in a compartment and have an acoustic wrap to assure quiet operation.
4. The outdoor unit control panel shall include a sliding window to access adjustable controls and an LED display for setup and diagnostics.
5. Unit cabinet shall be capable of withstanding 1500-hour salt spray test per ASTM-B117-16.

D. Fans

1. Outdoor fan shall discharge air vertically and be driven by a DC-inverter variable-speed motor with 64 steps that is capable of running down to 60 rpm.
2. Outdoor fan motor shall be totally-enclosed with permanently-lubricated bearings.
3. Motor shall be protected by internal thermal overload protection.
4. Fan blade shall be non-metallic and shall be statically and dynamically balanced.
5. Outdoor fan shall be protected by a raised non-metallic protective grille.

E. Compressors

1. Each outdoor unit module shall be equipped with two inverter-driven twin rotary compressors with full-range control to an accuracy of ± 0.1 Hz.
2. Compressor shall be totally enclosed in the machine compartment.
3. Compressors shall be equipped with factory-mounted crankcase heaters.
4. Internal safety logic shall protect the compressor from over-temperature operation.
5. Motor shall be suitable for operation in an R-410A refrigerant atmosphere.
6. Compressor assembly shall be installed on rubber vibration isolators.
7. To maximize compressor reliability, multiple compressors within a module shall be started and operated in variable patterns to ensure equal run time on all compressors.

8. To ensure maximum efficiency throughout the system operation range, no compressor is required to run at maximum speed under any condition.
- F. Outdoor Coil
1. Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.
 2. The coil configuration shall be 4-sided and fully separated from the machine compartment for more effective heat transfer and sound isolation.
 3. The coil fins shall have a factory-applied corrosion resistant blue-fin finish.
- G. Controls and Safeties: Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:
1. Controls:
 - a. Compressor speed to match the refrigerant flow and capacity with the system requirements.
 - b. Outdoor fan motor speed for higher efficiency and lower sound.
 - c. Oil control for improved system reliability and comfort
 - d. Pulse modulating valve control for precise control of the refrigerant distribution and accurate capacity management to avoid starving any units.
 - e. Control of compressor staging to maximize reliability and minimum run time on all compressors.
 - f. Module control of compressor operation, compressor speed, and outdoor heat exchanger surface to maximize efficiency and sound level and reliability across the entire operating range of the system.
 - g. Control of the outdoor heat exchanger surface (main vs sub heat exchangers) for maximum efficiency and comfort.
 2. Safeties: The following safety devices shall be part of the condensing unit:
 - a. High-pressure switch
 - b. Fuses
 - c. Crankcase heater
 - d. Fusible plug
 - e. Over current relay for the compressor
 - f. Thermal protectors for compressor and fan motor
 - g. Compressor time delay
 - h. Oil recovery system
 - i. Oil level sensor
 - j. Over-current sensor
 - k. Compressor suction and discharge temperature sensor
 - l. Compressor suction and discharge pressure sensor
- H. Electrical Requirements
1. All sizes shall utilize 208/230-3-60 or 460-3-60 (V-Ph-Hz) field power supply.
 2. Modular systems shall have separate field power supply to each module.
 3. Two-core, stranded, shielded low voltage cable shall be required for communication between outdoor and indoor unit.
 4. All power and control wiring must be installed per NEC and all local electrical codes.

- I. Refrigerant Piping and Line Lengths
 - 1. Piping connections shall be from the front or the bottom of the unit.
 - 2. The unit shall be capable of operating with maximum connected refrigerant line lengths of 3281 ft (actual).
 - 3. The outdoor unit shall have the ability to operate with a maximum height of 230 ft. between the outdoor and the lowest indoor unit.
 - 4. The maximum distance between the outdoor unit and the furthest fan coil shall not exceed 591 ft actual or 656 ft equivalent. No line size changes or oil traps shall be required.
 - 5. The system shall be capable of operating when the height difference between the upper and the lower fan coil is 131 ft.
- J. Auxiliary Refrigerant Components
 - 1. All field supplied copper tubing connecting the outdoor unit to the indoor unit shall use factory-supplied branching kits consisting of either Y joints or headers to ensure even refrigerant flow.
 - 2. To ensure piping flexibility the system shall allow having Y joints or headers downstream of another header.
 - 3. For modular systems, in order to maximize efficiency and comfort, a 3/8-in. oil balance line shall be used to allow the flow of oil and refrigerant between the modular units even when one of the units is not running.
 - 4. A flow selector box will be required to regulate the flow of high-pressure hot gas or high-pressure liquid to the fan coil requiring heating or cooling.
 - 5. Up to 8 fan coils, all requiring same duty cycle, may be connected to a single flow selector box.
 - 6. A fan coil that runs in cooling only shall not be required to connect to a flow selector box.
 - 7. The single port flow selector box can be installed up to 49 ft from the indoor unit.
 - 8. The multi port flow selector box can be installed up to 164 ft from the indoor unit.
 - 9. The single port flow selector box shall be wired from the indoor unit using a factory-supplied power and control wire harness.
 - 10. The multi port flow selector box shall be powered by a dedicated 208/230-1-60 field power supply.
 - 11. The single port flow selector box shall not require a drain connection.
 - 12. The multi port flow selector shall require a drain connection.
 - 13. The single port and multi port flow selector box shall include a galvanized steel enclosure, and shall be tested prior to shipment.
 - 14. The single port flow selector box shall include full interior insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify roof platform curbs are installed and dimensions are as instructed by manufacturer or large enough to fit and support condensing units.

- B. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM
- C. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- D. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.2 PREPARATION & COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.
- B. Coordinate location of water system fittings to ensure correct positioning for condensate drain pipe.
- C. Coordinate sequencing of construction of associated plumbing, HVAC, electrical supply and sheet metal contractor.

3.3 INSTALLATION

- A. Install in accordance with ARI 430.
- B. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
- C. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.
- D. Piping installation requirements are specified on plans and in specifications. Drawings indicate general arrangement of piping, fittings, and specialties.
- E. Do not place units on roof before roof curbs are installed.
- F. Install shut-off valves in inlet and outlet refrigerant piping.
- G. Install control wiring between remote control locations and unit.
- H. Install components furnished loose for field mounting.
- I. Install electrical devices furnished loose for field mounting.
- J. Install outdoor units on vibration isolation pads as recommended by manufacturer.
- K. Install refrigerant piping between indoor and outdoor units as indicated on Drawings. Refer to Section 23 23 00.

3.4 FIELD QUALITY CONTROL

- A. Furnish services of factory trained representative to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.
- B. Furnish manufacturers startup technician to startup all VRF systems; provide manufacturer's start-up forms for review and records.
- C. Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections.
- D. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.
- E. Furnish units fully charged with refrigerant and filled with oil.
- F. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

END OF SECTION

SECTION 26 01 00

GENERAL PROVISIONS

PART 1 - GENERAL

1.00 GENERAL PROVISIONS

1.01 GENERAL REQUIREMENTS

- A. The provisions of this section apply to all work specified in all sections of Division 26.
- B. The General Conditions, Supplementary Conditions, Special Requirements, and applicable portions of Division 1 of the Specification are a part of this Division and the requirements contained herein are supplementary to them.

1.02 PRINCIPAL WORK IN THIS SECTION

- A. Division 26 includes all in materials, equipment, fabrication, installation and tests required for fully operational and safe systems, including, but not limited to, all appurtenances and features, whether specified or shown on drawings, required for conformance with applicable Codes and approval by the Authorities Having Jurisdiction.
- B. Special Conditions
 - 1. All existing electrical, telephone, CATV and street/parking lot lighting systems shall remain fully operational until new systems are completely installed, tested and ready for final connection. Demolition work shall not start until new systems are completely installed, tested and approved and fully operational. See specification for "Sequence of Work".
 - 2. All existing manholes, handholes and vaults are full of water. Approximately two (2) inches of mud and debris are present on the bottom of all existing manholes, handholes and vaults. As part of the bid, the Contractor shall pump, clean and maintain all and new] existing manholes, handholes and vaults free from water, mud and debris for the duration of the contract. Electrical manholes contain energized medium voltage cables and access shall be coordinated with the Architect/Owner's Representative. The Contractor shall use qualified personnel having adequate experience working with medium voltage installations to work in electrical manholes. The Contractor shall use extreme caution and OSHA recommended safe measures.
 - 3. All existing materials and equipment which are required to be removed or disconnected (but are not indicated for use in the new work) shall be offered to the Architect/Owner's Representative for salvage. If declined by the Architect/Owner's Representative, the Contractor shall dispose of the existing materials and equipment off campus at a bonafide disposal area. Items indicated to be salvaged shall remain the property of the Owner and, if not indicated to be reused in the new work, shall be transported and delivered to an on-campus storage area as directed by the Architect/Owner's

Representative.

1.03 RELATED WORK AND REQUIREMENTS

- A. Related Work Specified Elsewhere:
- B. Coordination: Refer to Architectural, Civil, Structural and Mechanical Drawings for the construction details and coordinate the work of this Division with that of other Divisions. Order the work of this Division so that progress will harmonize with that of other Divisions and all work will proceed expeditiously. The work of this Division shall include direct responsibility for the correct placing and connection of electrical work in relation to the work of other Divisions.
- C. Examine other Divisions for work related to the work of this Division especially Division 25 - MECHANICAL.

1.04 REFERENCE STANDARDS

- A. By submitting a Bid, Contractor is deemed to represent himself as competent to accomplish the work of this Division in conformance with applicable Codes. In case of conflict between the Contract Documents and Code requirements, the Codes shall take precedence. Should such conflicts appear, cease work on the parts of the contract affected and immediately notify the Architect in writing. It shall be the Contractor's responsibility to correct, at no cost to the Owner, any work he executes in violation of Code requirements. Specific references to Codes elsewhere in this Division are either to aid the Contractor in locating applicable information or to deny him permission to use options which are permitted by Codes.
- B. Applicable Codes: (Current adopted editions unless otherwise noted):
 - 1. IBC - International Building Code, 2018.
 - 2. IECC - International Energy Conservation Code, 2009
 - 3. IESNA - Illuminating Engineering Society of North America
 - 4. NFC - National Fire Codes
 - 5. NFPA 70 - National Electrical Code, 2020.
- C. Where conflict or variation exists among Codes, the most stringent shall govern.

1.05 QUALITY ASSURANCE

- A. All equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
- B. All equipment and accessories shall be new, free from defects and listed by Underwriters' Laboratories, Inc. or bearing its label unless otherwise noted.

- C. All equipment and accessories shall be in compliance with the applicable standards and with all applicable National, State and local Codes.
- D. All items of a given type shall be the products of the same manufacturer. Contractor shall provide same manufacturer's product throughout the project.

1.06 SUBMITTALS

- A. Submittal requirements for Division 26 shall be in accordance with Division 1 except as modified herein. All time requirements shall be based on the notice to proceed date of the General Contract. All materials and equipment furnished under Division 26 shall be submitted to the Architect/ Owner's Representative for approval. Such approval shall be in writing from the Architect/ Owner's Representative including that which is exactly as specified. Any materials or equipment installed without written approval shall be subject to immediate removal.
- B. Submittals shall be packaged separately for each system or major piece of equipment and reviewed by the Contractor for verification of compliance with the contract documents prior to submitting. Separate, bound submittals shall be provided for each specification section to the. All interface between specification sections shall be indicated in each submittal. Any deviations from the specific materials or substitutions for items specified shall be itemized in the front of each submittal.
- C. Equipment submittal shall include manufacturer's name, model, type, number, finish, size and capacity of the equipment at the given conditions. This information shall be provided in bound submittals, each containing an index and all submittals. The number of copies shall be as indicated in Division 1. The title shall provide the project name, system identity, the specification number and the Contractor's name and address. This submittal shall be in addition to the shop drawings hereinafter specified. Partial submittals of material submitted from time to time are not acceptable and may be returned without review.
- D. Equipment Layout Drawings: "Equipment Layout Drawings" shall be provided for each equipment room, yard or area containing equipment items furnished under Division 26. Layout drawings shall consist of a plan view of the room or area (to a 1/4"=1'-0" minimum scale) showing projected outlines of all equipment, complete with dotted lines indicating all required clearances, including all clearances needed for removal or service. Location of all conduit and pull boxes shall be indicated. Drawings shall indicate any and all conflicts with other trades.
- E. General
 - 1. Architect's review of the submittal is only for general conformance with design concept of the project and general compliance with the information given in the contract documents. The submittal procedure is required in an effort to minimize the problems which occur due to the discovery of Contractor non-compliance at the construction site. The Contractor is responsible for confirmation and correlation of the dimensions, quantities and sizes, for information that pertains to fabrication methods or construction techniques and for coordination of work of all Divisions of the work. Deviations, if any, from Contract Documents shall be clearly and completely indicated (by a separate letter if deviations are extensive) in the submittals, and the lack of such is deemed complete compliance with Contract Documents without any deviations. Submittals favorably processed will not relieve the Contractor of responsibility for deviations not so reported nor for errors in the submittal.
 - 2. Contractor Stamp: All submittals shall be stamped with the following text or equivalent

and signed by the Contractor's representative.

"IT IS HEREBY CERTIFIED THAT THE PRODUCTS SHOWN AND MARKED IN THIS SUBMITTAL ARE IN COMPLIANCE WITH THE CONTRACT DOCUMENTS AND CAN BE INSTALLED IN THE ALLOCATED SPACES EXCEPT WHERE DEVIATIONS ARE NOTED.

CERTIFIED BY: _____ DATE: _____ "

3. All submittals shall be complete and with catalog data and information properly marked to show, among other things, equivalency of product (where substitution is requested), adequacy in capacity and performance to meet minimum capacities of performance as specified or indicated. Arrange the submittals in the same sequence as these specifications and reference (at the upper right-hand corner) the particular specification provision for which each submittal is intended. Incomplete submittals will be rejected.
4. Refer to the other sections of this Division for specific requirements.

B. Material List

Within 15 days after award of Contract, submit for approval a complete list of materials proposed for use. Furnish names and addresses of manufacturers, catalog numbers (where applicable) types and trade names. For purposes of uniformity, only one manufacturer will be accepted for each class or type of material. This list is in addition to Shop Drawings.

C. Shop Drawings:

Submit shop drawings with such promptness as to cause no delay in the work. Do not commence fabrication of the equipment until the approved drawings are received from the Owner's representative.

D. Other Submittals: As required by other sections of this Division.

1.07 SUBSTITUTIONS:

1. A sample of each item submitted for substitution shall be accompanying the submittal for review.
2. A unit price quotation shall be provided with each item intended for substitution. This quote shall include a unit price for the specified item and a unit price for the intended substitute item. The Contractor shall also provide a total (per item) of the differential payback to the Owner should the intended substitute item be approved as equivalent to that which is specified.

1.08 OPERATION AND MAINTENANCE MANUALS:

- A. The Contractor shall furnish operation and maintenance manuals for each electrical system and for each piece of equipment. The complete manual, bound in hardback binders or an approved equivalent, shall be provided to the Architect/Owner's Representative.] The number of copies

shall be as indicated in Division 1.] One (1) manual shall be furnished prior to the time that system or equipment tests are performed and the remaining manuals shall be furnished before the contract is completed. The following identification shall be inscribed on the cover the words "OPERATING AND MAINTENANCE MANUAL," the name and location of the building, the name of the Contractor and the contract number.

- B. The manual shall include the names, addresses and telephone numbers of each Subcontractor installing equipment and systems and of the local manufacturer's representatives for each item of equipment and each system. The manual shall have a table of contents and be assembled to conform to the table of contents with tab sheets placed before instructions covering each subject. The instruction sheets shall be legible with large sheets of drawings folded in. The manual shall include, but not be limited to, the following:
1. System layout showing components.
 2. Devices and controls.
 3. Wiring and control diagrams showing operation and control of each component.
 4. Sequence of operation describing start-up, operation and shutdown.
 5. Functional description of the principal system components.
 6. Installation instructions.
 7. Maintenance and overhaul instructions.
 8. Lubrication schedule including type, grade, temperature range and frequency.
 9. Safety precautions, diagrams and illustrations.
 10. Test procedures.
 11. Performance data.
 12. Parts list.
- C. The parts list for equipment shall indicate the sources of supply, recommended spare parts and the service organization which is reasonably convenient to the building site. The manual shall be complete in all respects for all equipment, controls and accessories provided.
- D. The manual shall include the following:
1. Final panelboard schedules (8-1/2"x11").
 2. Final motor control center schedules (8-1/2"x11").
 3. Coordination studies and short circuit calculations.
 4. Final test reports (including infrared scans).
 5. Catalog cuts of final approved light fixtures.

1.09 RECORD DRAWINGS:

- A. On one (1) set of contract drawings, kept at the site during construction, mark all work that is installed differently from that shown on plans, including revised circuitry, material or equipment. Sufficient dimensions shall be provided to locate all materials installed beneath and outside the building including, but not limited to, underground conduits, cabling, ground rods and stubouts.
- B. All changes or revisions to the contract drawings including, but not limited to, those indicated by amendment, change order, field order, written response to RFI/RFC or other contractual means shall be kept current as the work progresses and shall be incorporated onto the final record drawings.
- C. Accurately locate and dimension all underground and embedded conduit runs on the record drawings.
- D. The marked drawings shall be kept current as the work progresses and shall be available for inspection upon request.
- E. At the close of construction these or a copy of these drawings shall be turned over to the Architect/Owner's Representative for use in preparing record drawings. At the close of construction, prepare a set of accurate reproducible record drawings and turn them over to the Architect/Owner's Representative. At the close of construction, update the electronic files with the most current version of AutoCAD (AutoCAD 2002 as a minimum standard). Show all changes or revisions and turn them over to the Architect/Owner's Representative with one (1) complete set of reproducible drawings. The correct and completed record drawings and electronic files are a prerequisite to final contract payment.
 - 1. As part of the reproducible record drawings, the Contractor shall include:
 - a. Final motor control schedules as modified during construction.
 - b. Final panelboard schedules as modified during construction.
 - c. Final light fixture schedule as modified during construction.
- F. As part of the reproducible record drawings, the Contractor shall update the electronic drawing files for all 26700 and 26800 series drawings with the most current version of AutoCAD (AutoCAD 2002 as a minimum standard). Provide one (1) set of full size reproducible drawings for all signal systems (26700 and 26800 Series) which shall include exact "As-Built" device locations, "As-Built" interconnection drawings and "As-Built" riser diagrams and turn them over to the Architect/Owner's Representative. The correct and completed record drawings and electronic files are a prerequisite to final contract payment.]
- G. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification.
- H. The Architect shall interpret the drawings and the specifications, and his decision as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.
- I. In case of conflicts not clarified prior to Bidding deadline, use the most costly alternative (better quality, greater quantity, or larger size) in preparing the Bid. A clarification will be issued to the successful Bidder as soon as feasible after the Award and if appropriate a deductive change

order will be issued.

All provisions shall be deemed mandatory except as expressly indicated as optional by the word "may" or "option".

Accumulate the following and deliver to the Architect's representative prior to final acceptance of the work.

J. Record (as-built) Drawings:

1. Maintain in good order in the field office a complete set of electrical prints. Update the drawings daily with neat and legible annotations in red ink showing the work as actually installed.
2. The actual size, location and elevation of all buried lines, boxes, monuments, and stubouts shall be accurately located and diminished from building walls or other permanent landmarks.
3. Furnish the originals.

K. O&M Manuals: Furnish copies of an operating and maintenance manual as indicated in Division 1. Each manual shall be bound and indexed and shall include the following:

1. Operating and service instructions for systems and equipment as required by other sections of this Division. A spare parts list recommended for purchase by Owner shall be included.
2. Updated approved materials list, shop drawings, and catalog information as required by SUBMITTALS subsections.
3. List of material and equipment manufacturers (with names, addresses and phone numbers of local suppliers) in order to expedite ordering of replacement parts by the Owner. This list may be integrated with the material list.

L. Permits and Certificates of Inspection: Furnish the originals.

M. Testing procedures and test results required in this and other sections: Furnish two copies.

N. Other data required by other sections of this Division: Furnish two copies.

1.10 MATERIALS

- A. Materials shall be new, in accordance with the specifications of the Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturer's Association (NEMA), National Fire Production Association (NFPA), and the National Electrical Code (NEC), and shall have an Underwriter's Laboratories (UL) listing and bear their label where such services is available.
- B. Materials for the same purpose shall be of the same make and shall be the manufacturer's latest standard design that complies with the specification requirements.

1.11 SUBSTITUTIONS

- A. Substitutions will be allowed only in strict conformance with the General Conditions of the Contract and Division 1.
- B. All lighting fixture substitution submittals shall be provided with supporting space by space (to include site) point by point photometric calculations in conformance with Illuminating Engineering Society of North America (IESNA) guidelines to verify substituted lighting fixture(s) provide the required amount and quality of illuminance at the working plane.
- C. Whenever in specifications any materials, process, or article is indicated or specified by grade, patent, or proprietary name or by name of manufacturer such specification shall be deemed to be used for the purpose of facilitating description of material, process, or article desired and shall be substantially equal or better in every respect to that so indicated or specified. If material, process, or article offered by Contractor is not, in opinion of architect, substantially equal or better in every respect to that specified, then Contractor shall furnish material, process, or article specified. Burden of proof as to equality of any material, process, or article shall rest with Contractor. Contractor shall submit request together with substantiating data for substitution of an "or equal" item within thirty-five (35) days after award of contract. Provision authorizing submission of "or-equal" justification data shall not in any way authorize an extension of time for performance of this contract.
- D. When no specific make of material, apparatus or equipment is mentioned, a first-class specification grade product made by a well established manufacturer shall be used that conforms to the requirements of the contract documents and is acceptable to the Architect.
- E. The Contractor shall assume any extra costs to other work or trades resulting from the use of substitutions. All substitutions accepted shall be provided at no extra charge.

1.12 WORKMANSHIP AND INSTALLATION METHODS

- A. Workmanship shall be in conformance with the "NECA (National Electrical Contractors Association) Standards of Installation" and the best standard practice of the trade except where indicated otherwise.
- B. Execute the work so as to contribute to ease of operation and maintenance, maximum accessibility and best appearance. Execute it so that the installation will conform and adjust itself to the building structure, its equipment and its usage. The work shall be symmetrical, plumb, uniform, properly aligned and firmly secured in place.
- C. Install equipment in accordance with the manufacturer's instructions and recommendations unless otherwise noted or specified.

1.13 LOCATIONS, SIZES, ROUTINGS AND CLEARANCES

- A. For the purpose of clearness and legibility, the drawings are essentially diagrammatic. The size and location of equipment is shown to scale wherever possible, but the Contractor shall make use of all the data in the Contract Documents, and shall verify such information. Contractor is responsible for the equipment provided by him fitting in the spaces available while maintaining required working, ventilation, and equipment maintenance access space. Exercise particular care that such space is not infringed by the work of other Divisions.
- B. Conduit Routing: The drawings show the points of termination of the conduits, and may suggest a route for the conduit. However, it shall be the responsibility of the Contractor to install the conduits with a minimum number of bends in such a manner as to conform to the structure, avoid

obstructions, preserve headroom, keep openings and passageways clear, and meet all Code requirements with such offsets and special fittings as may be required. Conduit shall be run concealed in building structure unless otherwise indicated.

1.14 TESTS

A. General

1. Demonstrate that all components of the work of this Division have been provided and that they operate in accordance with the Contract Documents.
2. Provide instruments and personnel for tests and demonstrations. Submit signed test results.
3. Notify the Architect in writing, seven days in advance of tests to allow presence of his representative.

B. Specific: Refer to the other sections of this Division for test requirements.

Cleaning shall be done as the work proceeds. Remove waste and debris weekly to keep the site as clean as is practical.

Vacuum clean dirt and debris from interiors of switch-boards, panelboards, transformers, and similar items. Leave exposed parts of the electrical work in a neat, clean and usable condition, with painted surfaces unblemished and plated metal surfaces polished. Clean lighting fixtures and wipe lamps clean.

1.15 CLEANUP AND HOUSEKEEPING

- ##### A. Cleaning shall be done as the work proceeds. Remove waste and debris weekly to keep the site as clean as is practical.

Vacuum clean dirt and debris from interiors of switch-boards, panelboards, transformers, and similar items. Leave exposed parts of the electrical work in a neat, clean and usable condition, with painted surfaces unblemished and plated metal surfaces polished. Clean lighting fixtures and wipe lamps clean.

1.16 DESCRIPTION OF BID DOCUMENTS

- A. Contract Documents, the Contractor shall notify and secure directions from the Architect.
- B. Drawings and specifications are intended to complement each other. Where a conflict or ambiguity exists between the requirements of the drawings and the specifications, request clarification. Do not proceed with work without direction.
- C. The Architect/Owner's Representative shall interpret the drawings and the specifications. The interpretation by the Architect/Owner's Representative as to the true intent and meaning thereof and the quality, quantity and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.
- D. In the case of conflicts or ambiguities not clarified prior to the bidding deadline, use the most costly alternative (better quality, greater quantity and larger size) in preparing the bid. A

clarification will be issued to the successful bidder as soon as feasible after the award and, if appropriate, a deductive change order will be issued.

- E. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.

1.17 DEFINITIONS:

- A. "Provide" means furnish, install and connect unless otherwise described in specific instances.
- B. "Extend", "Submit", "Repair" and similar words mean that the Contractor shall accomplish the action described.
- C. "Codes" or "Code" means all codes, laws, statutes, rules, regulations, ordinances, orders, decrees, and other requirements of all legally constituted authorities and public utility franchise holders having jurisdiction.
- D. "Verify Location" when noted for an item, means that the locations of the item within the room is tentative and not necessarily as shown on the drawings. Contractor shall request the exact location of the item from the Architect's Representative during construction. The item may be located anywhere in the room at no additional cost to the Owner.
- E. "Products", "materials" and "equipment" are used interchangeably and mean materials, fixtures, equipment, accessories, etc.
- F. "Utility areas" are defined as mechanical, electrical, telephone, janitorial, and similar rooms or spaces which are normally used or occupied only by custodial or maintenance personnel. "Public areas" are defined as the rooms or spaces which are not included in the utility areas definition.

1.18 EXAMINATION OF SITE:

1.19 PERMITS, FEES AND INSPECTIONS:

- A. Obtain, schedule and pay for permits, licenses, approvals, tests, and inspections required by legally constituted authorities and public utility franchise holders having jurisdiction over the work.

1.20 ELECTRO-MECHANICAL REQUIREMENTS:

1.21 GUARANTEES:

- A. Guaranty requirements for Division 26 shall be in accordance with Division 1 except as modified herein.
- B. All materials and equipment provided shall be warranted for a minimum period of two (2) years from the official date of completion.
- C. See Section 26150 "Standby Generating System" for warranty requirements.
- C. Refer to Division 1 for guaranty format.

TEMPORARY ELECTRICAL SERVICE:

- D. The Contractor shall provide labor and materials required for the installation and maintenance of temporary lighting and required power sources for the Contractor's equipment inside the building or construction site and for pedestrian walkways during the period of construction.
- E. The building or construction site shall be sufficiently illuminated so that construction work can be safely performed. Special attention shall be given to adequately lighting stairs, ladders, pedestrian walkways, floor openings, etc. Walkway lights shall be controlled by a switch within the building or construction site.
- F. Power shall be on and all lighting shall be in operation before painting work commences.

1.22 PROGRESS OF UNDERGROUND CONSTRUCTION:

1.23 ELECTRICAL PHASING AND PHASE ROTATION:

1.24 ELECTRICAL SERVICE OUTAGES:

Written notice of proposed utility outages shall be delivered to the Architect/ Owner's Representative at least fourteen (14) days prior to the start of the proposed outage. Contractor shall be responsible for all the related work that may be required to provide continued electrical service. The Contractor shall be responsible for the sequencing of all work including, but not limited to, installation of new electrical lines, abandonment of existing electrical lines and interfacing between new and existing lines to ensure uninterrupted service.

Search

- B. Describe outages.

1.25 SEQUENCING OF ELECTRICAL WORK:

1.26 POSTED OPERATING INSTRUCTIONS:

1.27 TRAINING:

- A. User staff and maintenance personnel shall be thoroughly trained in the use of each system or major piece of equipment installed. This training shall be provided as part of the Contractors bid to supply the system or equipment. Additional training requirements shall be as specified in the subsequent sections of Division 26.

1.28 DELIVERY AND STORAGE:

- A. Equipment and materials shall be properly stored, adequately protected and carefully handled to prevent damage before and during installation. Equipment and materials shall be handled, stored and protected in accordance with the manufacturer's recommendations. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Plastic conduit shall be stored on even supports and in locations not subject to direct sunrays or excessive heat. Cables shall be sealed, stored and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Damaged or defective items shall be replaced with new items at no cost to the Owner. The Architect/ Owner's Representative] shall determine if a damaged or defective item is to be replaced with a new item. The decisions by the Architect/ Owner's Representative] in these matters shall be final.

1.29 FIELD TESTS:

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. **Copper** Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for specified types herein.
- C. Multiconductor Cable: Comply with NEMA WC 70 for specified types herein.

2.2 CONNECTORS AND SPLICES

- A. 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:

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
 - 6. Or equal.
- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- D. All cables shall arrive on the job site in un-broken packages.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Copper conductors: Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Insulation: Thermoplastic type THWN or THHN. Use conductors with 150 degrees C insulation in abnormally high ambient temperatures as applicable. Type THHN may be used in dry locations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. All conductors are to be installed in conduit/raceways.
- B. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS & FIRESTOPPING

- A. Provide sleeves for conduits passing through poured concrete walls and concrete or concrete fireproofed steel beams. Provide 18 gauge galvanized steel and place in correct position in forms before concrete is poured. Sleeve shall be at least $\frac{1}{2}$ " above finished floor all around. Pack void between sleeve and conduit as follows:
 - 1. Where conduit is run between floors in a fireproof shaft, pack with Duxseal
 - 2. Where conduit penetrates a fire separation, any of the following packing methods may be used to restore integrity of the separation if code approved: cement, mineral fiber sprayed with flame retardant coating or Dow Corning 3—6548 RTV silicon foam, 3M caulk #CP25, 3M putty #303 or equal. Seal shall be water tight and shall be accomplished prior to wire pulling.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: **Copper only** wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Compression type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: **Copper 5/8 inch in diameter by 8 feet long minimum.**

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- C. Conductor Terminations and Connections:
 - 1. Welded connectors
 - 2. Bolted connectors

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors in all circuit runs, in addition to those required by NFPA 70
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG unless otherwise noted insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a **1/4-by-4-by-12-inch** grounding bus.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. **Metal** Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are **2 inches** below finished floor or final grade unless otherwise indicated.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least **12 inches** deep, with cover.
1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer **and at the grounding electrode conductor where exposed**.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.
- B. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: **10** ohms.
 - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: **3** ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: **1** ohm(s).
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify electrical engineer of record promptly. Provide at notification alternate method of reducing ground resistance below the above noted compliant values.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. See Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks and manholes, and underground handholes, boxes, and utility construction.

1.2 SUBMITTALS

- A. Product Data: For surface raceways, underground raceways, wireways, spacers and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. EMT: ANSI C80.3.
- D. FMC: Zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket.

- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

- 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
- 2. Fittings for EMT: **compression** type.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. ENT: NEMA TC 13.
- B. RNC: NEMA TC 2, **Type EPC-40-PVC**, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

- A. 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
 - 4. Or equal
- C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type **1, 12 or 3R**, as indicated.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: **As indicated.**
- F. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

- A. 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:

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hoffman.
 - 2. Lamson & Sessions; Carlon Electrical Products.
 - 3. Or equal
- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel. **Manufacturer's standard enamel finish or in color selected by Architect per drawings.**
 - 1. 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. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
 - d. Or equal.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect.
 - 1. 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. Butler Manufacturing Company; Walker Division.
 - b. Enduro Systems, Inc.; Composite Products Division.
 - c. Hubbell Incorporated; Wiring Device-Kellems Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.
 - h. Or equal.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, **ferrous alloy**, Type FD, with gasketed cover.

- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- D. Metal Floor Boxes: **Cast metal, fully adjustable.**
- E. Nonmetallic Floor Boxes: Nonadjustable, round.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, **cast aluminum** with gasketed cover.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: PVC.
- I. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: **Rigid steel conduit, EMT, RNC, Type EPC-40-PVC, RNC, Type EPC-80-PVC.**
 - 2. Concealed Conduit, Aboveground: **Rigid steel conduit, EMT, RNC**
 - 3. Underground Conduit: Type EPC-40 or 80-PVC, direct buried.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): **LFMC or LFNC.**
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type **3R or 4X** as noted.
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: **EMT or rigid steel conduit.**
 - 2. Exposed and Subject to Severe Physical Damage: **Rigid steel conduit.** Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: **EMT**.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: **Rigid steel conduit**.
6. Raceways for Optical Fiber or Communications Cable: **EMT**.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4X in damp or wet locations.

C. Minimum Raceway Size: **1/2-inch** trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

- A. Conduit passing through roof: flash and counter flash. Method shall be compatible with roofing system and acceptable to the owner's representative.
- B. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- C. Keep raceways at least **6 inches** away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- D. Complete raceway installation before starting conductor installation.
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 1. Conduit shall not be imbedded in slabs on grade.
- H. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating sealing bushings to protect conductors, including conductors smaller than No. 4 AWG.
- I. All conduit stubs shall have insulated bushings.
- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than **200-lb** tensile strength. Leave at least **12 inches** of slack at each end of pull rope.
- K. Raceways for Optical Fiber and Communications Cable: Install as follows:
 1. **3/4-Inch** Trade Size: Install raceways in maximum lengths of **50 feet**.
 2. **1-Inch** Trade Size and Larger: Install raceways in maximum lengths of **75 feet**.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes

or terminations at distribution frames or cabinets where necessary to comply with these requirements.

- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- M. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed **30 deg F**, and that has straight-run length that exceeds **25 feet**.
 - 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: **125 deg F** temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: **155 deg F** temperature change.
 - c. Indoor Spaces Connected with the Outdoors without Physical Separation: **125 deg F** temperature change.
 - d. Attics: **135 deg F** temperature change.
 - 2. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F** of temperature change.
 - 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- N. Flexible Conduit Connections: Use maximum of **72 inches** of flexible conduit for **recessed and semirecessed lighting fixtures**, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- P. Set metal floor boxes level and flush with finished floor surface.
- Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than **6 inches** in nominal diameter.
 2. Install backfill as specified in Division 31 Section "Earth Moving."
 3. Install conduit in all underground conduit in trench with non-metallic spacers with spacing intervals as specified by the spacer manufacturer.
 4. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within **12 inches** of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 5. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
 6. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with **3 inches** of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of **60 inches** from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 7. Warning Planks: Bury warning tape approximately **12 inches** above direct-buried conduits, placing them **24 inches** o.c. Align tape along the width and along the centerline of conduit.
- B. Bury underground conduit (except under building) to a 24" minimum depth below finished grade to top of conduit or concrete envelope (when encased) except that for conduit below a road or driveway to dimension shall be a 30" minimum.
1. All conduit risers from below grade shall be PVC schedule 80 with the exception of risers to lighting pole may be PVC schedule 40.

3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
- C. Typewritten panelboard schedules for installation in panelboards.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panel boards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures:
 - 1. Dead Front: Secured to box with concealed hinges. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Typewritten Directory Card: Inside panel board door, mounted in transparent card holder.
- C. Phase, Neutral, and Ground Buses: **Hard-drawn copper.**
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: **Hard-drawn copper.**
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panel board Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following;**
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- C. Mains: **Circuit breaker.**
- D. Branch Over current Protective Devices: For all Circuit-Breaker Frame Sizes provide **Bolt-on** circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following;**
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: **Bolt-on** circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with **interrupting capacity** to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).
 - a. Provide GFCI type breakers as indicated on drawings and when required by code.
 6. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: suitable for number, size, trip ratings, and conductor materials rated for a minimum 75 degrees C.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: **Integrally mounted** relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to **NEMA PB 1.1**.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim 6'-7" above finished floor per NEC article 240.24 unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub two **1-inch (27-GRC)** empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub two **1-inch (27-GRC)** empty conduits into raised floor space or below slab not on grade.
- H. Each branch circuit with-in the panelboard enclosure shall be permanent label with the circuit number and the conductors shall be trained in a workmen like manner.
- I. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Wall-box motion sensors.
 - 3. Snap switches and wall-box dimmers.
 - 4. Solid-state fan speed controls.
 - 5. Wall-switch and exterior occupancy sensors.
 - 6. Communications outlets.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.
- C. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

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:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
5. Or equal.

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).
 - e. Or equal.

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, **non-feed** through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; GF20.
 - b. Pass & Seymour; 2084.
 - c. Or equal.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

- d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
 - e. Or equal.
- C. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 - e. Or equal.
 - 3. Description: Single pole, with factory-supplied key in lieu of switch handle.
- D. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - d. Pass & Seymour; 1251.
 - e. Or equal.

2.5 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for interior Spaces: **Smooth, white, high-impact thermoplastic.**
 - 3. Material for Damp Locations: **stainless steel** with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant **stainless steel** with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles **down**, and on horizontally mounted receptacles to the **left**.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with **white**-filled lettering on black face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in **enclosed switches, switchboards, motor-control centers.**

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA FU 1 for cartridge fuses.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following:**
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Service Entrance: Per coordination study, see section 26573.
- B. Feeders: Per coordination study, see section 26573.
- C. Motor Branch Circuits: **Class RK5**, time delay.
- D. Other Branch Circuits: **Class RK1, time delay, Class J, fast acting**.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION