

Project Manual

University of Colorado at Colorado Springs Replace AHU and RA System Columbine Hall

100% Construction Documents-Issued for Bid

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SECTION 01 00 00 – GENERAL CONDITIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Division 01 - General Requirements relates to and expands upon the Conditions of the Contract, including the General Conditions and the Supplementary Conditions, but does not supersede requirements specified in those documents or in the Owner/Contractor Agreement.
- B. Division 01 - General Requirements governs work under all other divisions of the Specifications, including Project Specifications issued under separate cover, and the Drawings.

1.2 PROJECT IDENTIFICATION AND PRINCIPAL ENTITIES

- A. University of Colorado Colorado Springs:
 - Ms. Carolyn Fox, RA
 - University of Colorado Colorado Springs
 - 1420 Austin Bluffs Parkway, CSB 209
 - Colorado Springs, CO 80918
 - (719) 255-3588
 - Cfox3@uccs.edu

1.3 PROJECT CONSULTANTS

- A. Mechanical Engineer:
 - Leffingwell Consulting Engineers, Inc.
 - Mr. Gary Leffingwell, P.E.
 - 775 Haystack Drive
 - Livermore, CO 80536
 - (719) 473-5998
 - garyl@leffingwellce.com
- B. Electrical Engineer:
 - CMO Consulting Engineers LLC
 - Ms. Charlene Bocek, P.E.
 - 11646 Sun Bear Trail
 - Golden, CO 80403
 - (303) 875-4037
 - cbocek@cmoengineering.com

- C. Owner: Wherever the word “Owner” is used in this Project Manual, it shall mean:
- Ms. Carolyn Fox, RA
University of Colorado Colorado Springs
1420 Austin Bluffs Parkway, CSB 209
Colorado Springs, CO 80918
(719) 255-3588
Cfox3@uccs.edu
- D. Owner's Representative: Wherever the word “Owner's Representative” is used in this Project Manual, it shall mean:
- Ms. Catherine Robbins, AIA
Wember Inc.
7350 E Progress Place Suite#100
Greenwood Village, CO 80111
(303) 868-5258
Crobbs@wemberinc.com
- E. General Contractor: Wherever the words “Contractor” or “General Contractor” are used in this Project Manual, they shall mean the contractor who is party to the Owner/Contractor Agreement.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. Single Contract: Unless otherwise indicated or specified, all Work indicated on the Drawings and described in the Specifications is to be executed under one prime contract between Owner and General Contractor.
- B. Summary of Work: The Work includes replacing the existing R22 DX cooling system in the office wing penthouse air handlers and selective demolition and installation of new return air openings, ducts and dampers above the existing ceiling in the office wing of Columbine Hall.
- C. The locations of all existing utilities, as indicated on the Drawings, are approximate. General Contractor shall be responsible for verifying location of all underground and above ground utilities prior to construction. Any damage to these utilities shall be the Contractor’s responsibility and they shall be repaired at no cost to the Owner.
- D. Failure to Visit Site: Will not relieve Contractor from necessity of furnishing materials or performing work that may be required to complete the Work in accordance with Drawings and Specifications without additional cost to Owner.

1.5 WORK BY OWNER

- A. Furnishings:
1. Movable cabinets.
 2. Furnishings.
 3. Small equipment.
 4. Rugs.
 5. Artwork.
 6. Other items noted on Drawings.

1.6 WORK BY OWNER OR UNDER SEPARATE CONTRACT

- A. Coordination and Cooperation:
1. Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts. Cooperate in the scheduling of work and in the use of space. Coordinate with Owner's Representative.

1.7 ACCESS TO SITE

1. Contractor's Access to Site: Limited to access routes as directed by the Owner.

1.8 COORDINATION WITH OCCUPANTS

- A. Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits, unless otherwise indicated.
1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 - a. Emergency Exits: Maintain all required fire exits from existing building at all times existing building is occupied during construction process.
 - b. Exit Doors, Stairways and Discharge Areas: Acceptable to local code authority.
 2. Related Requirements: See Section 01 35 16 Alteration Project Procedures.
- B. Disruptive Operations: Noisy and disruptive operations (such use of jack hammers and other noisy equipment):
1. Schedule and coordinate such operations with Owner.
 2. Upon notification from Owner, cease operations that are, in opinion of Owner, disruptive. Schedule such operations as described above.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Owner not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Owner's written permission.
 3. In general outages shall be scheduled at times coordinated with the Owner.
- D. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.
- E. Construction Parking: Parking for construction labor on site shall be paid by the Contractor.
- F. Owner Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.

1. Before partial Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of building.
2. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of building.

1.9 USE OF SITE

- A. General: Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits and as defined at the Pre-construction Conference.
- B. Limit use of premises to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 1. Owner Occupancy: Restrict access to extent required to allow for on-going occupancy of portions of the building outside the area of work.
 2. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Use of Existing Building: Maintain existing building in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.
 1. 1. Related Requirements:
 - a. Section 01 35 16 Alteration Project Procedures.
 - b. Section 01 50 00 Temporary Facilities and Controls.
- D. On-Site Work Hours: Work shall be generally performed inside the existing building during normal business working hours, Monday through Friday, unless specifically authorized by the Owner's Representative.
- E. Special Campus Restrictions:
 1. Areas in the vicinity of the building will be designated by Owner's Project Manager for the purposes of Contractor's staging, stockpiling, and vehicle access.
 2. No portion of the site may be used by Contractor without prior approval by Owner's Project Manager.
 3. Contractor personnel are prohibited from existing building interiors except as required to execute specific work indicated on Drawings.
 4. Contractor is prohibited from utilizing the building's computers, phones and internet access.
 5. Contractor and associated personnel and subcontractors are not permitted to use existing and toilet facilities and service sinks in the building for personal use, for cleaning tools, or for disposing of construction waste materials.
 6. Building keys will not be made available to Contractor. Access into and throughout the building will be arranged through Owner's Project Manager.
 7. Protect existing property from unauthorized access to building interiors, roofs, etc. Temporary work or storage of materials is not permitted to compromise building security.
 8. Temporary work must not compromise structural integrity.
 9. No construction waste materials may be disposed of in Owner's dumpsters or other Owner containers.

10. Construction areas shall be limited to the portions of the site indicated on Drawings.
11. Control smoke, dust, dirt, odors and other objectionable effects, and limit to the immediate area of construction. Contractor is responsible for cleaning other areas affected by noncompliance with this requirement, including contents of affected areas.
12. Clean work areas of debris, and "broom clean" no less frequently than at the end of each work day. Remove all debris from exterior site areas which could be wind blown. See Section 01 7000 for additional requirements.

F. Special Restriction:

1. All Contractor's personnel, including but not limited to subcontractors, suppliers, inspectors, laborers, and any personnel under contract to or in the direct employ of the Contractor are not permitted to interact with students of the existing college facility in any manner.
2. Contractor's Superintendent: Must be subject to a full background check by UCCS authorities and may not have any prior convictions related to drug abuse, child abuse, or similar violations of applicable law.

1.10 WORK SEQUENCE AND CONSTRUCTION PHASING

- A. Sequencing of Construction Plan: Before start of construction on site, submit three copies of construction plan regarding access to work; use of site; and scheduling and phasing of new, demolition and renovation work for acceptance by Owner and Architect. After acceptance of plan, construction sequencing shall comply with accepted plan unless deviations are accepted in writing.
1. No work may commence until Notice to Proceed is provided by the Owner.

1.11 HAZARDOUS COMMUNICATION REQUIREMENTS:

- A. All Contractors are responsible for compliance with mandatory federal rules and regulations concerning Hazard Communication, including, but not limited to those regulations contained in 29 CFR 191 0.1200 Hazard Communication, 1910.146 Confined Space, 1910.147 Lock-out Tag-out, 1910.1101 Asbestos, and 1926.62 Lead. Contractor and all subcontractors working at sites under the control of the Owner shall make available to the Architect, upon request, copies of the Hazard Communication Program used by their firm. In addition to this requirement, all regulations related to Multi-employer workplaces shall be adhered to. These regulations are found in 29 CFR 1910.1200, (e) (2) (I) through (e) (4) specifically:
- B. (e) (2) Multi-employer workplaces. Employers who produce, use, or store hazardous chemicals at workplace in such a way that employees of other employer(s) may be exposed (for example, employees of a construction contractor working on site) shall additionally ensure that the hazard communication programs developed and implemented under paragraph (e) include the following:
1. (e) (2) (i) The methods the employer will use to provide the other employer(s) with a copy of the safety data sheet, or to make it available at a central location in the workplace, for each hazardous chemical the other employer(s)' employees may be exposed to while working;
 2. (e) (2) (ii) The methods the employer will use to inform the other employer(s) of any precautionary measures that need to be taken to protect employees during the workplace's normal operating conditions and in foreseeable emergencies; and, (e) (2) (iii) The methods the employer will use to inform the other employer(s) of the labeling system used in the workplace.
 3. (e) (3) The employer may rely on an existing hazard communication program to comply with these requirements, provided that it meets the criteria established in this paragraph (e).

4. (e) (4) The employer shall make the written hazard communication program available, upon request, to employees, their designated representatives, the Assistant Secretary and the Director, in accordance with requirements of 29 CFR 1910.20 (e).
5. The referenced regulations were excerpted from 29 CFR 1910.1200. This excerpt shall not be relied upon for compliance with mandatory federal, state and local regulations. The Contractor shall comply with all such regulations and shall be solely liable for insuring that all requirements under applicable regulations are met.

1.12 PROJECT MANUAL FORMATS AND CONVENTIONS

- A. MasterFormat: This Project Manual is organized on the basis of the 2004 Edition of the Construction Specifications Institute (CSI) MasterFormat.
 1. In general, Section numbers are assigned six digits. The first two digits identify the Division (Level 1). The next two pairs of numbers, Levels 2 and 3, identify the subject matter of the section in order of increasing hierarchical specificity. In some cases, a Level 4 number is supplied following a decimal point, when clarity requires a higher degree of specificity. Level 5 numbers or letters are not assigned and are reserved for user-defined categories.
 2. The system of groups, subgroups and Divisions are listed in the Table of Contents of this Project Manual. It consists of 50 Divisions, Division 00 through Division 49, some of which are not used or are reserved for future expansion of the MasterFormat.
- B. Specification Language: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences.
 1. Omissions of words or phrases such as "the contractor shall", "in conformity therewith", "shall be", "as noted on the Drawings", "a", "the", are intentional.
 2. Supply omitted words or phrases by inference.
 3. Supply words "shall be" or "shall" by inference when colon is used within sentences or phrases.
 4. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases.

1.13 EXAMINATION OF SITE

- A. Failure to visit the site will in no way relieve any Contractor from the necessity of furnishing materials or performing work that may be required to complete work in accordance with the Contract Documents without additional cost to the OWNER. Bids will be accepted from only those bidders who attend the **mandatory** pre-bid conference at the job site.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 01 00 00

SECTION 01 03 00 - ADMINISTRATION AND SUPERVISION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Specification sections, apply to work of this section.

1.2 SURVEYS, LAYOUTS, AND LEVELS

- A. General: Working from lines and levels established by the existing building, and as shown in relation to the work, establish and maintain bench marks and other dependable markers to set the lines and levels for the work of construction as needed to properly locate every element of the work of the entire project. Calculate and measure required dimensions as shown (within recognized tolerances if not otherwise indicated); do not scale the drawings to determine dimensions. Continuously advise tradesmen performing the work of the marked lines and levels provided for use in the layout of work.

1.3 SUBMITTALS

- A. Within 10 days of the Notice to Proceed, the Contractor shall submit a Schedule of Values to be used in determining general progress of the project, and for determining percentage of work accomplished for progress payments. As a minimum, the Schedule of Values shall indicate the value of materials and labor for each major category of work. The value of materials and labor shall be shown separately.

1.4 PROGRESS SCHEDULE

- A. Furnish Project Schedule, as required by the General Conditions, not less than four copies in the form of: Bar chart, showing start and completion of each activity or unit of work and overall percentage of completion against time. Provide such details as required by the Consultant. The Contractor shall provide a detailed construction schedule within two weeks of the award and identify all materials with a lead time greater than 30 days. The Contractor shall provide weekly updates to the construction schedule throughout the duration of the project.

1.5 PROJECT RECORD DOCUMENTS

- A. Maintain at job site, one copy of:
 1. Contract Drawings
 2. Specifications
 3. Addenda
 4. Reviewed Shop Drawings
 5. Change Orders
 6. Other Modifications to Contract
 7. Field Test Records
 8. As-Built Drawings
- B. Maintain documents in clean, dry, legible condition and do not use record documents for construction purposes. Make documents available at all times for inspection by the Owner's Representative.

- C. Label each document "Project Record" in 1" or larger printed letters.
- D. Record drawing information in colored pencil with different colors for the various systems and defined by color legend.
- E. Record drawings and specifications shall include the following:
 - 1. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure. Location of concealed valves, dampers, controls, balancing devices, junction boxes, cleanouts, and other items requiring access or maintenance.
 - 2. Field changes of dimension and detail, changes made by Change Order or Field Order and details not on original contract drawings.
- F. Submit all record drawings to the Consultant at the completion of the project.

1.6 CLEANING

- A. **Cleaning and Protection Work:** At the time each unit of work or element of the construction is completed in each area of the Project, clean the unit or element to a condition suitable for occupancy and use (as intended), and restore minor or superficial damage. Replace units and elements which are damaged beyond successful restoration. Clean and restore adjoining surfaces and other work which was soiled or damaged (superficially) during the installation; replace other work damaged beyond successful restoration. Where the performance of subsequent work could possibly result in damage to the complete unit or element, provide protective covering or other provisions to minimize possible damage. Repeat cleaning and protection operations during remainder of construction period, wherever work might otherwise be damaged by sustained soiling or exposure.
- B. **During Construction:** Oversee cleaning and ensure that building, grounds, and public properties are maintained free from accumulation of waste materials and rubbish. At reasonable intervals during progress of work, clean up site and access and dispose of waste materials, rubbish, and debris. Grounds around the access areas shall be broom clean by the end of each day.
- C. **Final Cleaning:** Remove all discarded materials and equipment. Restore sidewalks, lawns, landscaping, driveways, etc. to the condition prior to commencement of work.

1.7 PROJECT SIGN

- A. A project sign is not required. Do not erect any project sign or jobsite sign of any kind, except warning signs, without written authorization of the Owner.

1.8 COORDINATION

- A. The Contractor shall coordinate the work so as not to interfere with the building custodian's normal cleanup activities.
- B. The Contractor shall be responsible for coordinating all the work of the project. The Contractor shall coordinate the efforts of all subcontractor(s) and the deliveries of suppliers so that the work progresses in an orderly fashion without delay towards timely completion of a complete project in accordance with the drawings and specifications.

- C. The Contractor shall note that concurrent with his work, other contractors, suppliers, and the Owner's facilities and maintenance personnel may be working in relatively close proximity. The Contractor will be solely responsible for coordinating his work with that of other contractors and will make no claims for failure to do so.

1.9 METHODS OF CONSTRUCTION

- A. The procedure and method of construction is the prerogative and the responsibility of the Contractor. If professional assistance is required to safely implement method of construction, the Contractor shall, on his own, employ professional help.

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 01 03 00

SECTION 01 04 00 - PROJECT COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1-Specification sections, apply to work of this section.

1.2 SUMMARY:

- A. Section Includes: Requirements for coordination, supervision and administration for Project, including but not necessarily limited to:
 - 1. Coordination.
 - 2. Administrative and supervisory personnel.
 - 3. General installation provisions.
 - 4. Cleaning and protection.
- B. Related Sections: For descriptions of the work of the entire Project within and outside of the work of this Contract: Section 01 01 00.

1.3 SUBMITTALS:

- A. Coordination Drawings: For locations where several elements of equipment, mechanical or combined mechanical and electrical work must be sequenced and positioned with precision in order to fit into the available space, prepare coordination shop drawings showing the actual physical dimensions at accurate scale required for the installation. Prepare and submit coordination drawings prior to purchase/fabrication/installation of any of the elements involved in the coordination.
- B. Staff Names: Within 10 days of Notice to Proceed, submit a list of the Contractor's principal staff assignments, including the Superintendent in attendance at the site. Submit addresses and telephone numbers, including after-hours telephone numbers for emergency response.

1.4 GENERAL COORDINATION:

- A. General: Each entity involved in the performance of work for the entire Project shall cooperate in the overall coordination of the work; promptly, when requested, furnish information concerning its portion of the work; and respond promptly and reasonably to the decisions and requests of persons designated with coordination, supervisory, administrative, or similar authority. Where necessary, prepare memoranda for distribution to each party involved outlining special procedures required for coordination.
- B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of schedules.
 - 2. Installation and removal of temporary facilities.
 - 3. Delivery and processing of submittals.
 - 4. Progress meetings.
 - 5. Project closeout activities.

- C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water and materials. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work. Refer to other sections for disposition of salvaged materials that are designated as the Owner's's property.
 - D. Site Utilization: In addition to the site utilization limitations and requirements indicated in Section 01010 and indicated by the Contract Documents, administer the allocation of available space equitably among entities needing access and space, so as to produce the best overall efficiency in the performance of the total work of the project. Schedule deliveries so as to minimize the space and time requirements for storage of materials and equipment on the site; but do not unduly risk delays in the work.
 - 1. The Contractor shall note that concurrent with his work, other contractors, suppliers, and the Owner's's facilities and maintenance personnel may be working in relatively close proximity. The Contractor will be solely responsible for coordinating his work with that of other contractors and will make no claims for failure to do so.
 - E. Coordination Meetings: Where necessary, schedule coordination meetings for this purpose on an as-needed basis.
 - F. Layout: It is recognized that the Contract Documents are diagrammatic in showing certain physical relationships of the various elements and systems and their interfacing with other elements and systems. Establishment and coordination of these relationships is the exclusive responsibility of the Contractor. Do not scale the drawings. Field measure all conditions prior to fabrication and construction. Lay out and arrange all elements to contribute to safety, efficiency and to carry the harmony of design throughout the Work. In case of conflict or undimensioned locations, verify required positioning with the Owner's Representative.
 - G. Substrate Examination: The Installer of each element of the work must examine the conditions of the substrate to receive the work, dimensions and spaces adjacent, tolerances, interfacing with other elements and services, and the conditions under which the work will be performed, and must notify the Contractor in writing of conditions detrimental to the proper or timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
 - H. Large and Heavy Equipment and Materials: Coordinate the movement of heavy items with shoring and bracing, so that the building structure will not be overloaded during the movement and installation. Where equipment or products to be installed on the roof are too heavy to be hand-carried, do not transport across roof deck; position by crane or other device so as to avoid overloading the roof deck.
- 1.5 COMPLETE SYSTEMS:
- A. It is the intent of the Contract Documents that all systems, including mechanical and electrical, be complete and functional to provide the intended or specified performance. The Contractor shall provide all incidental items and parts necessary to achieve this requirement.
 - B. Provide correctly sized power, utilities, piping, drains, services and their connections to equipment and systems requiring them, whether or not specific items are listed in the schedule at the end of this section.
- 1.6 MECHANICAL/ELECTRICAL/EQUIPMENT COORDINATION:
- A. Sequence, coordinate and integrate the various elements of equipment, mechanical work and electrical work so that various systems and mechanical plant will perform as indicated and be in harmony with other work of the building. The Owner's Representative, including the Project Architect or Engineer, will supervise the coordination, which is the exclusive responsibility of the Contractor.

- B. Install piping, ductwork and similar services straight and true, aligned with other work, close to walls and overhead structure, allowing for insulation, concealed (except where indicated as exposed) in occupied spaces, and out-of-the-way with maximum passageway and headroom remaining in each space.
- C. Install electrical work in a neat, organized manner with conduit and similar services in or parallel with building lines, and concealed unless indicated as exposed.
- D. Arrange all work to facilitate maintenance and repair or replacement of equipment. Locate services requiring maintenance on valves and similar units in front of services requiring less maintenance. Connect equipment for ease of disconnecting, with minimum of interference with other work.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION PROCEDURES:

- A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
- B. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged and defective items.
- C. Recheck measurements and dimensions, before starting fabrication or installation.
- D. Manufacturer's Instructions: Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in Contract Documents.
- E. Installation: Provide attachment and connection devices and methods necessary for securing work. Secure work true to line and level. Allow for expansion and building movement. Install each component during weather conditions and project status that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration. Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.
- F. Visual Effects: Provide uniform joint widths in exposed work. Arrange joints in exposed work to obtain the best visual effect. Refer questionable choices to the Owner's Representative for final decision.
- G. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the Owner's Representative for final decision.

3.2 CLEANING AND PROTECTION:

- A. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration at substantial completion.

- B. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

- C. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:
 - 1. Excessive static or dynamic loading.
 - 2. Water or ice.
 - 3. Solvents.
 - 4. Chemicals.
 - 5. Puncture.
 - 6. Abrasion.
 - 7. Heavy traffic.
 - 8. Soiling, staining and corrosion.
 - 9. Unusual wear or other misuse.
 - 10. Contact between incompatible materials.
 - 11. Misalignment.
 - 12. Excessive weathering.
 - 13. Unprotected storage.
 - 14. Improper shipping or handling.
 - 15. Theft.
 - 16. Vandalism.

END OF SECTION 01 04 00

SECTION 01 09 00 - REFERENCE STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification sections, apply to work of this section.
- B. Administration, Procedures, Codes.

1.2 SUMMARY:

- A. Section Includes: General information and listing of reference standards.

1.3 REFERENCE STANDARDS:

- A. Applicability of Standards: Except where Contract Documents include more explicit or stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into Contract Documents. Such standards are made a part of the Contract Documents by reference. Individual Sections indicate which codes and standards the Contractor must keep available at the project site for reference. Referenced standards take precedence over standards that are not referenced but generally recognized in the construction industry as applicable.
- B. Conflicting Requirements: Where compliance with two or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Owner's Representative for a decision before proceeding.
- C. Unreferenced Standards: Unreferenced standards are not directly applicable to the Work, except as a general requirement of whether the Work complies with recognized construction industry standards.
- D. Publication Dates: Where compliance with an industry standard is required, comply with standard in effect as of date of Contract Documents.
- E. Updated Standards: At the request of the Owner, Contractor or authority having jurisdiction, submit a Change Order proposal where an applicable code or standard has been revised and reissued after the date of the Contract Documents and before performance of Work affected. The Owner will decide whether to issue a Change Order to proceed with the updated standard.
- F. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activities. Copies of applicable standards are not bound with the Contract Documents.
- G. Where copies of standards are needed for proper performance of a recognized construction activity, the Contractor shall obtain copies directly from the publication source.

- H. Although copies of standards needed for enforcement of requirements may be part of required submittals, the Owner reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION (Not applicable)

END OF SECTION 01 09 00

SECTION 01 15 00 - ADMINISTRATION, PROCEDURES, CODES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1-Specification sections, apply to work of this section.
- B. Reference Standards.

1.2 SUMMARY:

- A. Section Includes: General administrative requirements and procedures and related applicable codes.

1.3 CODES:

- A. Obtain all permits, inspections, approvals, and certificates required by law. Conform to all laws, ordinances, rules and regulations applicable to the location of the Project.

Governing Regulations: In addition to the above, conform to the following standards and regulations:

- 1. International Building Code, 2018 edition.
 - 2. International Mechanical Code, 2018 edition.
 - 3. International Plumbing Code, 2018 edition.
 - 4. International Fire Code, 2018 edition.
 - 5. National Electric Code, 2018 edition (NFPA No. 70).
 - 6. All State regulations.
- B. Publication Dates: Comply with codes and standards in effect at the date of the Contract Documents, except where a standard of a specific date or edition is indicated.

1.4 ATTACHMENTS TO CONCRETE:

- 1. No drilled inserts or powder-actuated fasteners are permitted by any trade in pre-stressed concrete except as specifically authorized by the General Contractor and carried out under the direct supervision of his Superintendent.
- B. Only those devices with a maximum controlled penetration of 0.75" or less will be permitted, unless specifically indicated on the structural details in the Project Drawings. Make holes through slabs by means of sleeves placed no closer than 2" from tensioning cables. Core drilling will not be permitted unless unavoidable and as specified in Section 01045.

1.5 CONTRACTOR'S CONSTRUCTION SCHEDULE:

- A. Furnish Construction Schedule, as required by General Conditions, not less than 4 copies. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.
- B. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the Work.
- C. Coordinate the Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests and other schedules.
- D. Bar Chart Schedule:
 - 1. Prepare a fully developed, horizontal bar chart type Contractor's construction schedule. Submit within 30 days of the date established for "Commencement of the Work".
 - 2. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated in the "Schedule of Values".
 - 3. Within each time bar, indicate estimated completion percentage in 10% increments. As Work progresses, place a contrasting mark in each bar to indicate Actual Completion.
 - 4. Include listing of Subcontractors, suppliers and materials men with name of contact person, address and phone number
- E. Updating:
 - 1. The schedules shall be updated and reissued weekly and shall reflect actual job progress, delays or gains of time and any rescheduling. The original schedule and each updating shall be furnished in 4 copies to the Owner's Representative. All costs for this scheduling shall be borne by the Contractor. Submit Owner's Representative copies as a part of each pay request which will not be processed without such updates.
 - 2. When schedule revisions affect the submittals schedule, revise that schedule and submit to Owner's Representative with revised Construction Schedule.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Properly carton, crate, cover and protect materials, products and equipment for shipping, handling and storing. Use appropriate means for hoisting and loading which will prevent damage or overstress to items being handled or shipped. Store them under roof in controlled environment whenever feasible otherwise store off the ground under suitable coverings properly secured against wind and weather. Protect all items from rain, snow, moisture, wind, cold, heat, frost, sun, staining, discoloration, deterioration and physical damage from any cause. Refer to individual sections for specific requirements.

1.7 ENVIRONMENTAL HEALTH AND SAFETY:

- A. Physical, Life, and Fire Safety: There will be joint contractor and Owner's responsibilities to control physical hazards (i.e., compressed gases, welding, electrical, safety netting, cranes, scaffolding, supplies on the roof and electrical) which may endanger the health of contractor or Owner's employees, students, patients, and visitors as may cause property damage.

- B. During the construction phase, the Owner's Physical Plant staff will monitor all construction projects for compliance with acceptable safety practices. The following minimum items are included:
1. Exit corridors and exit doors will not be blocked without making prior arrangements for alternate exit routes.
 2. Contractor will provide physical barriers with appropriate warning signage to protect public areas from construction work.
 3. Contractor will conduct daily inspections to eliminate fire hazards and any other safety hazards which may adversely affect Owner's employees, students, visitors, and patients.
 4. Contractor will provide signs used for proper identification of construction areas.
 5. Contractor will provide an adequate number of fire extinguishers to be available on-site for emergency use in the construction area.
 6. Contractor and Owner will provide emergency notification phone numbers to be posted in all construction areas.
- C. OSHA Hazard Communication Standard:
1. Every Contractor or subcontractor performing work shall have to comply with this standard. Compliance includes joint Owner and Contractor responsibilities for the purpose of providing timely communications and information sharing with regard to hazardous materials and chemicals and chemical sources which may be present on-site or brought in by the Contractor. Owner's Physical Plant representatives will discuss right-to-know issues with the Contractor or his representative during the pre-construction conference(s).
 2. Owner will provide Contractor with the following:
 - a. Information regarding hazardous chemicals and agents to which they may be exposed while on the job site. Medical Safety Data Sheets (MSDSs) will be provided by the Owner.
 - b. Precautions that employees shall take to lessen the possibility for exposure by employment of appropriate protective measures.
 - c. Precautionary methods to take in a foreseeable emergency.
 3. The Contractor is responsible for all safety training and environmental surveillance of their workers.
 4. The Contractor shall inform and provide designated Owner's Representative with the following information:
 - a. Material safety data sheets for all chemicals they introduce into the workplace(s).
 - b. The information regarding potential sources of pollutants which may be entrained in Owner's air intakes (i.e., roofing tar fumes, nuisance dusts, exhaust from internal combustion engines, welding or cutting fumes, and asbestos - if damaged or encountered during the course of their work).
- D. Asbestos Control: There may be asbestos containing materials within the existing building where work will be performed under this contract.
1. The presence of asbestos-containing materials on the job site does not mean a problem exists. Areas where asbestos is friable and not contained are of concern.
 2. There are several Owner and Contractor responsibilities regarding asbestos. These are:
 - a. The Owner Shall:
 - 1) Notify the Contractor of the condition and location(s) where asbestos is known to be present or may be reasonably be encountered (i.e., insulations, ceiling tiles, floor tiles, fire doors, wall and ceiling plasters, concrete, grouting, etc.).
 - 2) Request that undamaged asbestos-containing materials are not damaged.
 - 3) Require Contractors to report suspected asbestos problems to the Owner.
 - 4) Require that the Contractor train and monitor their own employees where applicable.
 - 5) Coordinate with the Contractor when response action is required by either the Owner's Asbestos Abatement Team or by a Subcontractor.
 - 6) Monitor areas where friable asbestos is present during construction/renovation projects for its own records and purpose. Monitoring results can be shared with Contractors but are in no way to be used for Contractor employee monitoring.

- 7) Have the final word on all asbestos-related concerns and contractual arrangements.
- b. The Contractor Shall:
 - 1) Notify the Owner of any suspected or existing problem involving asbestos and cease work in that area until the Owner has assessed the situation.
 - 2) Be responsible for all environmental/industrial hygiene surveillance of their work staff and subcontractors.
 - 3) Not create problems which can result in asbestos exposure to building occupants.
- E. Carcinogenics: Contractor or any subcontractor shall not knowingly install or cause to be installed any material or product containing carcinogenics.

1.8 OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

- A. The Contractor shall have sole responsibility for compliance on the job site to all applicable portions of the Occupational Safety and Health Act. The Contractor is responsible for other regulatory requirements as they relate to occupational Health and Safety requirements. For example, NIOSH, ANSI, and MSA.
- B. Protection of life, health and public welfare as it relates to the execution of the construction contract is the responsibility of the Contractor. The Owner's Representative may, at their discretion, observe, inspect, or comment on plans, procedures, or actions employed at the project as they relate to safety of life, health or public welfare. If conditions are imposed by the Owner which interfere with, or imply actions detrimental to safety, written notice shall be returned to the Owner for action prior to affecting any unsafe conditions.
- C. Contractors shall use OSHA Lock Out / Tag Out procedures when working with energized equipment.
- D. All contractors entering confined spaces owned by CU or while conducting work under contract with CU shall develop a written program and utilize procedures that, at a minimum, comply with all federal, state and local confined space standards and all applicable regulatory requirements. Contractors shall, independent of the University, monitor the space to obtain their own data to ensure a safe entry and exit. Any data generated by a contractor's confined space entry, should be provided to the Facilities Management confined Space Program Manager.
- E. When contractors perform work that may involve Facilities Management controlled permit required confined spaces, Facilities Management will:
 - 1. Inform contractors of permit required confined spaces and that entry is allowed only after compliance with the confined space entry standard;
 - 2. Require contractors planning to enter a confined space to provide the Facilities Management Confined Space Program Manager in charge of that space, 48-hour advance notice of such planned entry. The contractor's entry will be in accordance with the current Occupational Safety and Health Administration confined space entry standard and a signed document stating such, shall be provided to the FM Confined Space Program Manager prior to entry.
- F. The FM Confined Space Program Manager, following receipt of notice of contractor planned entry, will:
 - 1. Apprise contractor of the hazards identified in the confined space and of any prior experience that is documented on the space;
 - 2. Appraise the contractor of any precautions or procedures that UCCS has implemented for the protection of workers in or near the confined space.

1.9 HOT WORK PERMITS

- A. UCCS is using FM Global Hot Work Permit Program as an essential tool in preventing fires in our buildings. The permit is just a tool and does not disclose all precautions for every hot work application. All hot work on campus shall be strictly supervised while the work is being performed.
- B. UCCS Hot Work Permit
 1. Permits are required for all work involving open flames or producing heat and/or sparks (ie brazing, cutting, grinding, soldering torch applied roofing and welding)
 2. Permits are required for all hot work in existing buildings. Permits are not required for ground up construction.
 3. Contact the Department of Public Safety to obtain a Hot Work Permit 24 hours (business hours) prior to your scheduled work. Ron Honn (255-3201 (rhonn@uccs.edu <<mailto:rhonn@uccs.edu>> or Cindy Norton (255-3212) cnorton@uccs.edu <<mailto:cnorton@uccs.edu>>).
 4. Permits are to be picked up from the Department of Public Safety front desk, or may be dropped off at your construction site.
 5. Review your permit precautions checklist before proceeding with your work and display the permit in the work area.
 6. Once work is completed, complete the hot work permit process by signing off on who did the work and that the fire watch requirement was completed.
 7. Return the completed Hot Work Permit to the Department of Public Safety for their recordkeeping.
- C. Individuals or firms who obtain a permit shall fully read, understand and implement the requirements of the permit.
- D. Any person or firm who conducts hot work without the full implementation of the permit requirements shall be fined five hundred dollars (\$500) the first time and one thousand dollars (\$1,000) for subsequent occurrences. When the requirements of the hot work permit are not being implemented, the improper activities shall be stopped immediately until a hot work permit is obtained. Contractor shall be responsible for any damages caused as a result of improper hot work activities or the work stoppage. Any contractor who is found to be in non-compliance a third time, will not be allowed to work on campus until further notice by Facilities Services.
- E. UCCS project managers shall have the authority to stop improper or non-permitted hot work activities.

1.10 PERMITS

- A. The contractor must post permit(s) in a prominent location at the jobsite including all inspection reports. The contractor shall have an updated set of contract documents available at the jobsite for all inspections.

1.11 INSPECTIONS

- A. The Contractor must schedule all required inspections 48 hours in advance by calling UCCS Project Manager or directly contacting their designated inspectors. Inspectors will complete these inspections within 48 hours with the exception of weekends and state holidays.
- B. The contractor is required to arrange for the all inspections as required by the Building Inspection Record and CRS 24-30-1303 including but limited to Footings/Foundations, Concrete, Framing, Lath and Gypsum Board, Fire Resistant Penetrations, Mechanical/Energy Efficiency and Roofing.

- C. Re-inspections: A re-inspection fee may be assessed for each inspection or reinspection when such portion of work for which inspection is called is not complete or when corrections called for are not made.
- D. The Contractor will be responsible for all cost related to re-inspections and will be billed at the testing agency bill-out rate for re-inspections.

1.12 UNIVERSITY OF COLORADO SEXUAL HARASSMENT POLICY

- A. Contractors should be aware of and review the University of Colorado at Colorado Springs policies that prohibit discrimination and harassment on the basis of race, color, national origin, sex, age, disability, creed, religion, sexual orientation or veteran status. These policies are located on the web at: <http://www.uccs.edu/hr>. Contractor personnel must adhere to these policies and conduct themselves in a manner that does not discriminate or harass as a result of interacting with an around the University of Colorado faculty, staff and students and visitors.

1.13 FIRE ALARM INTERRUPTION

- A. Contractor shall contact UCCS Public Safety at 719-255-3201 or e-mail rhonn@uccs.edu <<mailto:rhonn@uccs.edu>> prior to all interruptions or shutdowns of fire alarm systems. Interruptions or shutdowns shall be scheduled three (3) working days in advance with UCCS Department of Public Safety and UCCS Project Manager. Contractor shall provide a fire watch as directed by UCCS Public Safety during interruption or shutdown.
- B. The Contractor shall be responsible for preventing nuisance alarm due to activities at their work site. Common sources of nuisance alarms are:
 - 1. Smoke (soldering, welding, cooking, etc.)
 - 2. Grinding
 - 3. Dust (drilling, sweeping, canister vacuums, sand blasting, etc.)
 - 4. Water leaking (plumbing leaks, overflows)
 - 5. Water sprayed on or near detectors (pressure washing or cleaning with water)
 - 6. Popcorn or other food burning in microwaves
 - 7. Static electricity (covering or uncovering detectors)
 - 8. Changing filters on air handling units (dust)
 - 9. Steam (leaks, pressure pop-offs)
 - 10. Broken or frozen sprinkler heads
 - 11. Sprinkler drain valves turned by mistake
 - 12. Vandalism
- C. Precautions to prevent nuisance alarms are:
 - 1. During construction projects, treat all buildings, except totally new construction, as though they were occupied buildings with live systems.
 - 2. Do not assume that all detectors are in plain sight. Contact University personnel for verification.
 - 3. Maintain dust control measures per UCCS Standards:
 - a. Maintaining barriers
 - b. Covering air returns
 - 4. Asking UCCS personnel to cap or disable smoke detectors (Note any capping or disabling of fire safety devices is to be done ONLY by UCCS personnel, not contractors.)
 - 5. Avoiding recirculation of dust or smoke through the building air handling system.
 - 6. Follow campus hot work procedures.
 - 7. Do not expose fire alarm devices to water or extreme temperatures.
 - 8. Contact Alarm Systems Supervisor for any actions that affect fire detection, alarm, and suppression systems.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION (Not applicable)

END OF SECTION 01 15 00

SECTION 01 30 00 - SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification sections, apply to work of this section.

1.2 SUMMARY:

- A. Section Includes: Administrative and procedural requirements for submittal and review of product data, shop drawings, samples and similar items required by the specifications.

1.3 ADMINISTRATIVE SUBMITTALS:

- A. Refer to other Division-1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to:
 - 1. Schedules.
 - 2. Permits.
 - 3. Applications for payment.
 - 4. Performance and payment bonds.
 - 5. Insurance certificates.
 - 6. List of Subcontractors.
 - 7. Schedule of Values.
 - 8. Inspection and test results.
 - 9. Closeout documents.
 - 10. Coordination drawings.
- B. Administrative submittals are for information and record and do not require action on the part of the Owner's Representative except where not in conformity with the Contract Documents. If such non-conformity is observed, the Owner's Representative will notify the Contractor within two weeks of the Owner's Representative's actual receipt of the non-conforming document. Failure to observe or notify by the Owner's Representative on any issue does not relieve Contractor of compliance with Contract Documents.

1.4 SUBMITTAL LOG

- A. A submittal Log is included at the end of this section. The Contractor is required to submit information pertaining to each of the listed items. The Contractor shall update the Submittal Log on a timely basis, and shall bring the log to scheduled progress meetings for coordination and review.

1.5 SUBMITTAL PROCEDURES:

- A. General: the Contractor shall make submittals to the Owner's Representative only after the Contractor has reviewed and fully coordinated all aspects of construction regarding each submittal. The Contractor shall indicate his action except for samples and selection submittals.
- B. Submittals which lack the Contractor's review, coordination, and action will be returned to the Contractor without action.
- C. Coordination: Coordinate the preparation and processing of submittals with the performance of construction activities. The Contractor shall transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay. The contractor is wholly responsible for the submittal process, its timing, and any related delay.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - 3. Distribute submittals to related subcontractors for comment to assure the timely coordination of the work.
 - 4. The Owner's Representative reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
 - 5. If, during the Contractor's submittal review, any inconsistency, conflict, or deviation from or with the Contract Documents becomes apparent, it is the Contractor's responsibility to inform the Owner's Representative immediately of all concerns in writing.
- D. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, **including time for resubmittals.**
 - 1. Allow 2 weeks from receipt of the submittal by the Owner's Representative for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Owner's Representative will advise the Contractor when a submittal being processed must be delayed for coordination.
 - 2. If an intermediate submittal is necessary, process the same as the initial submittal.
 - 3. Allow 2 weeks from receipt of the submittal by the Owner's Representative for reprocessing each submittal.
 - 4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Owner's Representative sufficiently in advance of the Work to permit processing, including resubmittals of incomplete or rejected submittal items.
- E. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
 - 1. Provide a space approximately 4" x 5" on the label or beside the title block on Shop Drawings to record the Contractor's review and approval markings and the action taken.
 - 2. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of Contractor.
 - d. Name and address of Subcontractor.
 - e. Name of manufacturer.
 - f. Number and title of appropriate Specification Section.
- F. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Owner's Representative using a transmittal form. Submittals received from sources other than the Contractor will not be returned.

1. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

G. Submittal Reviews:

1. **The Owner's Representative will provide two submittal reviews, one initial review and one follow up review. After the second review, if the submittals do not meet the requirements of the Contract Documents, the Contractor shall provide compensation to the Owner's Representative for additional submittal reviews.**

1.6 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Bar-Chart Schedule: Prepare a fully developed, horizontal bar-chart-type, contractor's construction schedule. Submit within 14 days after the date established for "Commencement of the Work" or "Notice to Proceed."
1. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated in the "Schedule of Values."
 2. Within each time bar, indicate estimated completion percentage in 10 percent increments. As Work progresses, place a contrasting mark in each bar to indicate Actual Completion.
 3. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.
 4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically the sequences necessary for completion of related portions of the Work.
 5. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.
 6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on the schedule to allow time for the Owner's Representative's procedures necessary for certification of Substantial Completion.
- B. Schedule Updating: Revise the schedule after each meeting, event, or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting. Schedule updating is required prior to the processing of all Contractor's application for payment.
- C. Schedule of Values: Within ten (10) days after the date of the notice of contract award but no later than prior to any request for payment will be considered, the Contractor shall submit to the Owner a complete, itemized schedule of the values of the various parts of the Work, aggregating the total sum of the Contract and separating material costs from other costs. Such schedule shall include as costs the material costs of all subcontractors under the Contractor and the costs of all materials to be taken from the Contractor's or subcontractors' own stocks of material. The schedule of values shall be submitted on forms supplied by the Owner and, if required, supported by such evidence as to its correctness as the Owner may direct. Each item on the schedule of values shall include its proper share of overhead and profit. The schedule of values shall be used for the estimates and progress payments provided for in this Agreement. Along with such schedule of values, the Contractor shall submit a schedule of estimated monthly application amounts to be submitted over the course of the Project to assist the Owner in arranging payments.

1.7 SHOP DRAWINGS:

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings. Do not use Shop Drawings without an appropriate final stamp indicating action taken.
- B. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Include the following information:
 - 1. Dimensions.
 - 2. Identification of products and materials included.
 - 3. Compliance with specified standards.
 - 4. Notation of coordination requirements.
 - 5. Notation of dimensions established by field measurement.
- C. Initial Submittal: Submit one correctable, translucent, reproducible print and one blue- or black-line print each for the Owner's Representative's review. The Owner's Representative will return the reproducible print. The Contractor will provide prints of marked up sepia as may be required for his use and that of his Subcontractors and suppliers.
- D. Final Submittal: Submit 6 copies for final action by the Owner's Representative. The Owner's Representative shall return one copy to the Contractor. The Contractor shall be responsible for procuring copies of the final submittal so that desired distribution can be made to the Contractor's field office, his home office, the Record Documents, the fabricator, and any others requiring in the submittal.
- E. Where shop drawings are indicated to be submitted for "information only", submit three sets of prints to Owner's Representative and retain one set for Project Record Documents.

1.8 PRODUCT DATA:

- A. Collect **ALL** Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard or special color charts, rough-in diagrams and templates, standard wiring diagrams and performance curves. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as "Shop Drawings". Product Data Submittal shall be provided in a vinyl covered 8 ½"x11" 3-ring binder. Product Data shall be organized within the binder into sections corresponding to specification sections. Provide a labeled tabbed divider between each section. Provide an index and a Contractor and Owner contact page at the front of the binder page.
- B. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information.
 - 1. Manufacturer's printed recommendations.
 - 2. Compliance with recognized trade association standards.
 - 3. Compliance with recognized testing agency standards.
 - 4. Application of testing agency labels and seals.
 - 5. Notation of dimensions verified by field measurement.
 - 6. Notation of coordination requirements.
- C. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed by the Contractor.

- D. Initial Submittal: Submit 6 copies for action by the Owner's Representative. The Owner's Representative shall return one copy to the Contractor. The Contractor shall be responsible for procuring copies of the final submittal so that desired distribution can be made to the Contractor's field office, his home office, the Record Documents, the fabricator, and any others involved in the submittal.
- E. Submittal is for information and record, unless otherwise indicated; and therefore, initial submittal is final submittal unless returned by the Owner's Representative marked with a revise and resubmit action which indicates an observed non-compliance.

1.9 SELECTIONS SUBMITTAL:

- A. Where selections of colors, patterns, textures are specified to be made by the Owner's Representative, assemble complete samples of all specified or approved products for all specification sections and submit to Owner's Representative. Review specifications and assemble all such samples for a combined single submittal. Indicate on the transmittal the latest date for selections to be made for each item to permit delivery of material in accordance with Progress Schedule. Allow a minimum of two weeks for Owner's Representative's action. Owner's Representative's action is limited solely to the specified selections or rejection of submittal items not in accordance with Specifications.

1.10 QUALITY ASSURANCE SUBMITTALS

- A. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.
- B. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.
 - 1. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.
- C. Inspection and Test Reports: Where standard tests are specified for products, including equipment, which tests are not performed at the job site, follow procedures for Product Data. For field inspection and tests specified to be performed by independent agencies, such agencies shall transmit directly one copy each to the Owner's Representative, his consulting engineer where applicable, and the Contractor with an extra copy for Record Documents.

1.11 OWNER'S REPRESENTATIVE'S ACTION

- A. Except for submittals for the record or information, where action and return is required, the Owner's Representative will review each submittal, mark to indicate action taken, and return to the Contractor.
 - 1. Compliance with specified characteristics is the Contractor's responsibility.
- B. Action Stamp: The Owner's Representative will stamp each submittal with a uniform, action stamp. The Owner's Representative will mark the stamp appropriately to indicate the action taken, as follows:
 - 1. Final Unrestricted Release: When the Owner's Representative marks a submittal "No Exception Taken," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.
 - 2. Final-But-Restricted Release: When the Owner's Representative marks a submittal "Make Corrections Noted," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.

3. Returned for Resubmittal: When the Owner's Representative marks a submittal "Revise and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - a. Do not use, or allow others to use, submittals marked "Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.
 4. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Owner's Representative will return the submittal marked "Action Not Required."
- C. Unsolicited Submittals: The Owner's Representative will return unsolicited submittals to the sender without action.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION (Not applicable)

END OF SECTION 01 30 00

SECTION 01 45 00 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification sections, apply to work of this section.

1.2 SUMMARY

- A. Work Included: This section establishes general requirements in addition to those indicated in the General Conditions of the Contract for Construction pertaining to cutting, fitting, and patching of the work required to:
 - 1. Make the several parts fit properly.
 - 2. Uncover work to provide for installation, inspection, or both, of ill-timed work.
 - 3. Remove and replace work not conforming to requirements of Contract Documents.
 - 4. Patch new construction into existing construction.
- B. Related Work:
 - 1. In addition to requirements specified, upon the Consultant's request, uncover work to provide for inspection of covered work, and remove samples of installed materials for testing.
 - 2. Do not cut or alter work performed under separate contract without the Consultant's written permission.

1.3 DEFINITION:

- A. "Cutting and patching" is hereby defined to include but is not necessarily limited to the cutting and patching of nominally completed and previously existing work, in order to accommodate the listed requirements. Cutting and patching is further defined to include integral cutting and patching during the manufacturing, fabricating, erecting and installing process for individual units of work.
- B. Demolition is recognized as an example of a related but separate category of work, which may also require cutting and patching as defined in this section; refer to Selective Demolition Section.

1.4 RESPONSIBILITIES:

- A. Contractor shall be responsible for all cutting, fitting and patching, including attendant excavation and backfill, required to complete the Work or to:
 - 1. Make its several parts fit together properly.
 - 2. Uncover portions of the Work to provide for installation of ill-timed work.
 - 3. Remove and replace defective work or work not conforming to requirements of Contract Documents.
 - 4. Remove samples of installed work as specified for testing.
 - 5. Provide routine penetrations of structural and non-structural surfaces for installation of mechanical and electrical work.
- B. Refer to other sections of the specifications for specific cutting and patching requirements and limitations applicable to individual units of work.

1.5 SUBMITTALS:

- A. Proposals for Cutting and Patching: Submit a written request to the Owner's Representative well in advance of executing any cutting or alteration which affects:
 - 1. Work of the Owner or any separate contractor.
 - 2. Structural value or integrity of any element of the Project.
 - 3. Integrity or effectiveness of weather exposed or moisture-resistant elements or systems.
 - 4. Efficiency, operational life, maintenance or safety of operational elements.
 - 5. Visual qualities of sight-exposed elements.
 - 6. Cutting new openings in existing structural concrete walls, floors and suspended slabs.
 - 7. Cutting new openings in existing roofs and roofing materials.
 - 8. Cutting exterior walls.
 - 9. Cutting into shafts.
- B. Include description of why cutting and patching cannot reasonably be avoided, how it will be performed, how structural elements will be reinforced, products to be used, firms and trades to perform the work, approximate dates of the work, and anticipated results in terms of variations from the work as originally completed (structural, operational, visual and other qualities of significance).
- C. List utilities that will be disturbed or otherwise affected by work, including those that will be relocated and those that will be out-of- service temporarily. Indicate how long utility service will be disrupted.
- D. Where cutting and patching involves addition of reinforcement to structural elements, submit details and engineering calculations, from a Licensed Professional Engineer, to show how reinforcement is integrated with the original structure.
- E. Approval by Owner's Representative to proceed with proposed cutting-and-patching does not waive his right to later require complete removal and replacement of work found to be unsatisfactorily cut-and-patched.

1.6 QUALITY ASSURANCE:

- A. Requirements for Structural Work: Do not cut and patch structural work in a manner resulting in a reduction of load-carrying capacity or load/deflection ratio.
- B. Operational and Safety Limitations: Do not cut and patch operational elements and safety-related components in a manner resulting in a reduction of capacities to perform in the manner intended or resulting in decreased operational life, increased maintenance, or decreased safety.
- C. Visual Requirements: Do not cut and patch work which is exposed on the exterior or exposed in occupied spaces of the building, in a manner resulting in a reduction of visual qualities or resulting in substantial evidence of the cut-and-patch work, both as judged solely by the Owner's Representative. Remove and replace work judged by the Owner's Representative to be cut-and-patched unsatisfactorily, visually.

1.7 PROJECT CONDITIONS:

- A. Where cutting and patching of existing construction is required, prior to start of work, inform Owner of existing construction to be disturbed. Owner will determine if existing construction contains asbestos. Do not proceed with work until Owner has made an examination. Refer to Section 01105.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Use materials that are identical to existing materials. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Inspect existing conditions of Project, including elements subject to damage or to movement during cutting and patching.
- B. After uncovering work, inspect conditions affecting installation of products, or performance of work.
- C. Report unsatisfactory or questionable conditions to the Owner's Representative in writing; do not proceed with work until Owner's Representative has provided further instructions.

3.2 PREPARATION:

- A. Temporary Support: Provide adequate support for work to be cut, to prevent failure. Do not endanger other work.
- B. Protection: Provide adequate protection of other work during cutting-and-patching, to prevent damage; and provide protection of the work from adverse weather exposure. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas. Take all precautions necessary to avoid cutting existing pipe, conduit or ductwork serving the building, but scheduled to be removed or relocated until provisions have been made to bypass them.

3.3 CUTTING AND PATCHING:

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting-and-patching at the earliest feasible time and complete without delay.
 - 1. Cutting: Cut work by methods least likely to damage work to be retained and work adjoining. Review proposed procedure with original Installer where possible, and comply with his recommendations. Cut holes and slots neatly to size required and temporarily cover openings when not in use.
 - 2. In general, cut work with sawing and grinding tools. Do not use hammering and chopping tools. Core drill openings through concrete work where possible.
 - 3. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.
 - 4. Cut through concrete and masonry using a cutting machine such as a Carborundum saw or diamond core drill.
 - 5. Fit work airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

- B. Patching: Patch with seams which are durable and as invisible as possible. Comply with specified tolerances for the work. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
1. Restore exposed finishes of patched areas; and, where necessary extend finish restoration onto retained work adjoining, in a manner which will eliminate evidence of patching. Where a patch occurs in a smooth painted surface, extend final paint coat over the entire unbroken surface containing the patch.
 2. Where removal of walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary to achieve uniform color and appearance.
 3. Patch, repair or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance.

END OF SECTION 01 45 00

SECTION 01 54 00 - SAFETY AND HEALTH

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Specification sections, apply to work of this section.

1.2 WORK COVERED BY THIS SECTION

- A. This section is applicable to all work covered by this contract.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. OSHA General Industry and Health Standards (29 CFR 1910), Publications V2206; OSHA Construction Industry Standards (29 CFR 1926). One source of these regulations is OSHA Publication 2207, which includes a combination of both Parts 1910 and 1926 as they relate to construction safety and health. It is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.
- C. National Emission Standards of Hazardous Air Pollutants (40 CFR, Part 61).
- D. Environmental Protection Agency (EPA) Final Rule (40 CFR Part 761) dated July 17, 1985.

1.4 DEFINITION OF HAZARDOUS MATERIALS

- A. Refer to hazardous and toxic materials/substances included in Subparts H and Z of 29 CFR 1910; and to others as additionally defined in Fed. Std. 313. Those most commonly encountered include asbestos, polychlorinated biphenyls (PCB'S), explosives, and radioactive material, but may include others. The most likely products to contain asbestos are sprayed-on fireproofing, insulation, boiler lagging, pipe covering and likely products to contain PCB'S are transformers, capacitors, voltage regulators, and oil switches.

1.5 QUALITY ASSURANCE:

- A. Safety Meeting: Representatives of the Contractor shall be prepared to discuss, in detail, the measures he/she intends to take in order to control any unsafe or unhealthy conditions associated with the work to be performed under the contract. If directed by the Owner, this meeting may be held in conjunction with other meetings which are scheduled to take place prior to start of work under this contract. The level of detail for the safety meeting is dependent upon the nature of the work and the potential inherent hazards. The Contractor's principal on-site representative(s), the general superintendent and his/her safety representative(s) shall attend this meeting.

- B. Contractor Responsibility: The Contractor shall assume full responsibility and liability for compliance with all applicable regulations pertaining to the health and safety of personnel during the execution of work, and shall hold State of Colorado and its Consultants harmless for any action on his/her part or that of his/her employees or subcontractors, which results in illness, injury or death.
- C. Compliance With Regulations for Hazardous Materials: All work, including contact with and handling of hazardous materials, the disturbance or dismantling of structures containing hazardous materials and/or the disposal of hazardous materials shall comply with the applicable requirements of 29 CFR 1926/1910 or 40 CFR 761. Work involving the disturbance, dismantling of asbestos or asbestos containing materials; the demolition of structures containing asbestos; and/or the disposal and removal of asbestos, shall also comply with the requirements of 40 CFR, Part 61, Subparts A and M. All work shall comply with applicable state and municipal safety and health requirements. Where there is a conflict between applicable regulations, the most stringent shall apply.

1.6 SUBMITTALS

- A. Accident Reporting: A copy of each accident report, which the Contractor or subcontractors submit to their insurance carriers, shall be forwarded to the Owner's Representative as soon as possible, but in no event later than seven (7) calendar days after the day the accident occurred.
- B. Permits: When hazardous materials (if any) are disposed of off site, submit copies of permits from applicable, Federal, state, or municipal authorities and necessary certificates that the material has been disposed of as per regulations.
- C. Other Submittals: Provide a plan of action for handling work protection from the fall exposure, and protection of the public at the ground level. Submittal shall contain the following as a minimum.
 - 1. Number, type, and experience of employees to be used for the work.
 - 2. Description of how applicable safety and health regulations and standards are to be met.
 - 3. Type of protective equipment and work procedures to be used.
 - 4. Identification of possible hazards, problems, and proposed control mechanisms.
 - 5. Protection of public or others not related to the operation.
 - 6. Interfacing and control of subcontractors, if any.
 - 7. Copy of the Contractor's safety manual

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT:

- A. Special facility, devices, equipment, clothing, and similar items used by the Contractor in the execution of work shall comply with the applicable regulations.

2.2 HAZARDOUS MATERIALS

- A. The contractor shall bring to the attention of the Owner any material suspected of being hazardous which he/she encounters during execution of the work. A determination will be made by the Owner as to whether the Contractor shall perform tests to determine if the material is hazardous. If the Owner directs the Contractor to perform tests, and/or if the material is found hazardous and additional protective measures are needed, a contract change may be required, subject to applicable provisions of this contract.

PART 3 - EXECUTION

3.1 STOP WORK ORDERS

- A. When the Contractor or his/her subcontractors are notified by the Owner's Representative(s) of any noncompliance with the provisions of the contract and the action(s) to be taken, the Contractor shall immediately, if directed, or within 48 hours after receipt of a notice of violation correct the unsafe or unhealthy condition. If the Contractor fails to comply promptly, all or any part of the work being performed may be stopped by the Owner or Owner's Representative with a "Stop Work Order". When, in the opinion of the Owner or Owner's Representative satisfactory corrective action has been taken to correct the unsafe and unhealthy condition, a start order will be given immediately. The Contractor shall not be allowed any extension of time or compensation for damages by reason of or in connection with such work stoppage.

3.2 PROTECTION

- A. The Contractor shall take all necessary precautions to prevent injury to workers, the public, building occupants, or damage to property. For the purposes of this contract, the public or building occupants shall include all persons not employed by the Contractor or a subcontractor working under his/her direction.
- B. Storing, positioning or use of equipment, tools, materials, scraps, and trash in a manner likely to present a hazard to the public or building occupants by its accidental shifting, ignition, or other hazardous qualities is prohibited.
- C. Obstructions: No corridor, aisle, stairway, door of exit shall be obstructed or used in such a manner as to encroach upon routes of ingress or egress utilized by the public or building occupant, or to present unsafe or unhealthy conditions to the public or building occupant.
- D. Work shall not be performed in any area occupied by the public or employees unless specifically permitted by the Contract or the Owner's Representative, and unless adequate stops are taken for the protection of the public or employees.
- E. Alternate Precautions: When the nature of the work prevents isolation of the work area and the public or building occupants may be in or pass through, under or over the work area, alternate precautions such as the posting of signs, the use of signal personal, the erection of barricades or similar protection around particularly hazardous operations shall be used as appropriate.
- F. Public Thoroughfare: When work is to be performed over a public thoroughfare such as a sidewalk, lobby, or corridor, the thoroughfare shall be closed, if possible, or other precautions taken such as the installation of screens or barricades. When the exposure to heavy falling objects exists, as during demolition, special protection of the type detailed in 29 CFR 1910/1926 shall be provided.
- G. Fall Protection: The Contractor shall comply with OSHA regulation 1926.500 in its entirety for the entire duration of this project. Any violation of these regulations shall cause the project to be shut down until full compliance is achieved. Repeated violations may result in termination of the Contract.

END OF SECTION 01 54 00

SECTION 01 60 00 - MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.

1.3 DEFINITIONS

- A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.
 1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 2. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
 3. "Foreign Products," as distinguished from "domestic products," are items substantially manufactured (50 percent or more of value) outside the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50 percent) by persons who are not citizens of, nor living within, the United States and its possessions are also considered to be foreign products.
 4. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
 5. "Equipment" is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.4 QUALITY ASSURANCE

- A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
 1. When specified products are available only from sources that do not, or cannot, produce a quantity adequate to complete project requirements in a timely manner, consult with the Owner's Representative to determine the most important product qualities before proceeding.
 2. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to the fullest extent possible.
- B. Compatibility of Options: When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each prime contractor is responsible for providing products and construction methods that are compatible with products and construction methods of other prime or separate contractors.
 2. If a dispute arises between prime contractors over concurrently selectable, but incompatible products, the Owner's Representative will determine which products shall be retained and which are incompatible and must be replaced.
- C. Foreign Product Limitations: Except under one or more of the following conditions, provide domestic products, not foreign products, for inclusion in the Work:
1. No available domestic product complies with the Contract Documents.
 2. Domestic products that comply with the Contract Documents are available only at prices or terms substantially higher than foreign products that comply with the Contract Documents.
- D. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.
1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
 5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
 6. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
 7. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.

1.6 SUBSTITUTIONS:

- A. Basis: After execution of the Contract, the Owner's Representative will consider substitutions of products in place of those specified or approved only if the specified product or products, through no fault of the Contractor or his Subcontractors, cannot be delivered in time to meet the construction schedule or is no longer available.
- B. Procedure: Make written request for the substitution documenting fully the above reason. Include complete data on the proposed substitution substantiating compliance with the Contract Documents including product identification and description, performance and test data, references and samples where applicable, and an itemized comparison of the proposed substitution with the products specified or otherwise approved, with data relating to Contract time schedule, design and artistic effect where applicable, and its relationship to separate contracts. Accompany the request by accurate installed cost data on the proposed substitution in comparison with the product specified.
- C. Consideration: Making such requests for substitutions is a representation by the Contractor that:
 - 1. The Contractor has personally investigated the proposed substitute product and determined that it is equal or superior in all respects to that specified and will carry the same warranty;
 - 2. The cost data are complete and include all related costs under this Contract but excludes costs under separate contracts and excludes Design Consultant's re-design costs, and the Contractor waives all claims for additional costs related to the substitution which subsequently become apparent;
 - 3. The Contractor will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects.
- D. When approved by the Owner's Representative, such substitution will be documented by Change Order modifying the Specifications. The Contract Sum will be changed only if the substitution results in a cost savings to the Owner.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, new at the time of installation.
 - 1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and the intended use and effect.
 - 2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
- B. Product Selection Procedures: The Contract Documents and governing regulations govern product selection. Procedures governing product selection include the following:
 - 1. Proprietary Specification Requirements: Where Specifications name only a single product or manufacturer, provide the product indicated. No substitutions will be permitted.
 - 2. Semiproprietary Specification Requirements: Where Specifications name 2 or more products or manufacturers, provide 1 of the products indicated. No substitutions will be permitted.
 - a. Where Specifications specify products or manufacturers by name, accompanied by the term "or equal" or "or approved equal," comply with the Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.

3. Nonproprietary Specifications: When Specifications list products or manufacturers that are available and may be incorporated in the Work, but do not restrict the Contractor to use of these products only, the Contractor may propose any available product that complies with Contract requirements. Comply with Contract Document provisions concerning "substitutions" to obtain approval for use of an unnamed product.
4. Descriptive Specification Requirements: Where Specifications describe a product or assembly, listing exact characteristics required, with or without use of a brand or trade name, provide a product or assembly that provides the characteristics and otherwise complies with Contract requirements.
5. Performance Specification Requirements: Where Specifications require compliance with performance requirements, provide products that comply with these requirements and are recommended by the manufacturer for the application indicated.
 - a. Manufacturer's recommendations may be contained in published product literature or by the manufacturer's certification of performance.
6. Compliance with Standards, Codes, and Regulations: Where Specifications only require compliance with an imposed code, standard, or regulation, select a product that complies with the standards, codes, or regulations specified.
7. Visual Matching: Where Specifications require matching an established Sample, the Owner's Representative's decision will be final on whether a proposed product matches satisfactorily.
 - a. Where no product available within the specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category.
8. Visual Selection: Where specified product requirements include the phrase "... as selected from manufacturer's standard colors, patterns, textures ..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Owner's Representative will select the color, pattern, and texture from the product line selected.
9. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

- A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.
 1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

END OF SECTION 01 60 00

SECTION 01 70 00 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for project closeout, including but not limited to:
 - 1. Inspection procedures.
 - 2. Project record document submittal.
 - 3. Operating and maintenance manual submittal.
 - 4. Submittal of warranties.
 - 5. Final cleaning.

1.3 PROJECT COMPLETION AND FINAL INSPECTION

- A. The Contractor shall file a written notice with the Owner's Representative that the work in the opinion of the Contractor, is complete under the terms of the contract.
- B. Within ten (10) days after the Contractor files written notice that the work is complete, the Owner's Representative, the Owner and the Contractor shall make a "final inspection" of the project to determine whether the work has been completed in accordance with the contract documents. A final punch list shall be made by the Owner's Representative in sufficient detail to fully outline to the Contractor.
 - 1. Work to be completed, if any;
 - 2. Work not in compliance with the drawings and specifications, if any;
 - 3. Unsatisfactory work for any reason, if any.
- C. The required amount of copies of the punch list will be countersigned by the Owner's Representative and the Owner and will be transmitted by the Owner's Representative to the Contractor and the Owner.

1.4 ADVERTISEMENT AND FINAL PAYMENT

- A. Prior to final payment to the Contractor, the Owner shall advertise the project as set forth in Article 50 of the General Conditions of the Contract.
- B. Before the Principle Representative may advertise, the Contractor shall:
 - 1. Deliver to the Owner's Representative:
 - a. Closing-out Checklist and Contractor Close-out forms with all items completed.
 - b. Final pay request accounting for final additional changes to the Contract Sum, including deductions for uncorrected work and deductions for reinspection payments. The final pay request shall reflect a reduction of the retainage to zero. The final pay request amount shall show the total Contract Sum, as adjusted by change orders, previous payments, and the sum remaining due.
 - c. All guaranties and warranties

- d. All statements to support local sales tax refunds.
 - e. Three complete bound sets of required operating maintenance instructions and manuals.
 - f. One set of drawings showing all job changes (as-built drawings)
2. Complete start-up testing of systems, and demonstrate to the operating personnel of the Principal Representative proper operation and maintenance of all newly installed or refurbished equipment.
 3. Deliver tools, spare parts, extra stock, and similar items.
 4. Make final change-over of permanent locks and transmit keys to the Owner. Advise the Owner personnel of change-over in security provisions.
 5. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
 6. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

1.5 RECORD DOCUMENT SUBMITTALS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Owner's Representative's reference during normal working hours.
- B. Record Drawings (as-built drawings): Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
 1. Mark record sets with erasable pencil; use other colors to distinguish between variations in separate categories of the Work. Define colors by color legend on front sheet.
 2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
 3. Note related Change Order numbers where applicable.
 4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
- C. Record Specifications: Maintain one complete copy of the Project Manual, including addenda, and one copy of other written construction documents such as Change Orders and modifications issued in printed form during construction. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot otherwise be readily discerned later by direct observation. Note related record drawing information and Product Data.
- D. Maintenance Manuals: Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder. Include the following types of information:
 1. Emergency instructions.
 2. Spare parts list.
 3. Copies of warranties.
 4. Wiring diagrams.
 5. Recommended "turn around" cycles.
 6. Inspection procedures.
 7. Shop Drawings and Product Data.
 8. Fixture lamping schedule.

1.6 MISCELLANEOUS KEYS, SWITCHES, ETC.

- A. At the completion of the project, all loose keys for hose bibs; adjustment keys and wrenches for door closers and panic hardware, and keys for electric switches, electrical panels, etc., shall be accounted for and turned over to the Owner.

1.7 WARRANTIES

- A. The Contractor and each sub-contractor shall remedy any defects to faulty materials or workmanship and pay for any damage to other work resulting therefrom, which shall appear in his work within a period of one year from the date of Notice of Acceptance and in accordance with the terms of any special warranties provided in the contract. The Owner shall give notice of observed defects with reasonable promptness.
- B. Upon completion of his work, the Contractor shall deliver to the Consultant in duplicate, a written warranty based on the provision of this Article properly signed and notarized. Warranty shall be addressed to the Owner.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 CLOSEOUT PROCEDURES

- A. Operating and Maintenance Instructions: Arrange for each installer of equipment that requires regular maintenance to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items:
 - 1. Maintenance manuals.
 - 2. Record documents.
 - 3. Spare parts and materials.
 - 4. Tools.
 - 5. Lubricants.
 - 6. Fuels.
 - 7. Identification systems.
 - 8. Control sequences.
 - 9. Hazards.
 - 10. Cleaning.
 - 11. Warranties and bonds.
 - 12. Maintenance agreements and similar continuing commitments.

- B. As part of instruction for operating equipment, demonstrate the following procedures:
 - 1. Start-up.
 - 2. Shutdown.
 - 3. Emergency operations.
 - 4. Noise and vibration adjustments.
 - 5. Safety procedures.
 - 6. Economy and efficiency adjustments.
 - 7. Effective energy utilization.

3.2 FINAL CLEANING

- A. General: General cleaning during construction is required by the General Conditions and included in Section "Temporary Facilities".
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
 - 1. Complete the following cleaning operations before requesting final inspection:
 - a. Remove labels that are not permanent labels.
 - b. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 - c. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
 - d. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
 - e. Clean the site, including landscape development areas, of rubbish, litter and other foreign substances. Sweep paved areas broom clean; remove stains, spills and other foreign deposits. Rake grounds that are neither paved nor planted, to a smooth even-textured surface.
- C. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.
- D. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove waste materials from the site and dispose of in a lawful manner. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

END OF SECTION 01 70 00

SECTION 01 71 00 - CLEANING

PART 1 - GENERAL

1.1 CLEANING

- A. Clean-up During Construction: Each contractor shall keep the building and premises free from all surplus material, waste material, dirt and rubbish caused by his employees or work, and at the completion of his work he shall remove all such surplus material, waste material, dirt and rubbish, as well as his tools, equipment and scaffolding, and shall leave his work clean and spotless, unless more exact requirements are specified. In case of dispute, the owner may remove all such items and charge the cost of such removal to the contractor.
1. Each sub-contractor shall perform his clean-up daily and shall transport his rubbish to an on-site location designated by the Contractor who will arrange for its removal.
 2. Use of College dumpsters by the Contractor or his subcontractors is prohibited.
- B. Cleaners: With the exception of clean-up of the site and cleaning specifically assigned to Contractors under various sections of the specifications, all final clean-up of exterior and interior of the building shall be done by professional cleaners.
- C. Final Clean-up:
1. Exterior: In addition to items specified below, any new surfaces on exterior, concrete, metal, etc. shall be carefully and thoroughly cleaned.
 2. Glass: Both sides of all glass in work areas shall be carefully and thoroughly cleaned by professional window cleaners and left absolutely clean and free from paint, grease, dirt, etc.
 3. Hardware: Clean and polish all hardware and leave clean and free from paint, grease, dirt, etc.
 4. Plumbing: Clean and polish all plumbing fixtures, fittings, and exposed plated piping. Leave clean and free from paint, grease, dirt, etc. Remove all labels.
 5. Electrical: Clean and polish all electric fixtures, including glassware, switchplates, etc., and leave clean and free from paint, grease, dirt, etc.
 6. Equipment: Carefully and thoroughly clean all items of equipment, mechanical, electrical, cabinets, ductwork, etc.
 7. Floors: Thoroughly clean all floors. Mop resilient floor coverings with warm water and mild detergent as recommended by manufacturer of the tile, then thoroughly machine buff. Vacuum and clean carpeting. Damp mop or scrub concrete floors as required to leave them thoroughly clean when site or building is turned over to the Owner.
- D. Completion: The entire work inside and out, and the entire premises shall be in first-class, clean condition upon completion before being accepted by the Owner and the Owner.

END OF SECTION 01 71 00

SECTION 01 74 00 - WARRANTIES AND BONDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

- A. Section Includes: General administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.
- B. Related Sections:
 - 1. Refer to the General Conditions for terms of the Contractor's special warranty of workmanship and materials.
 - 2. General closeout requirements: Section 01700
 - 3. Specific requirements for warranties for Work, products and installations: Individual Sections of Divisions-2 through -16
 - 4. Certifications and other commitments and agreements for continuing services to Owner: Applicable portions of Contract Documents.
- C. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and Subcontractors required to countersign special warranties with the Contractor.

1.3 DEFINITIONS:

- A. Standard Product Warranties: Preprinted written warranties published by individual manufacturers for particular products and specifically endorsed by the manufacturer to the Owner.
- B. Special Warranties: Written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.4 GENERAL WARRANTY REQUIREMENTS:

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.5 SUBMITTALS:

- A. Submit written warranties to the Owner prior to advertisement of the Notice of Contractor's Settlement. If the Notice of Acceptance designates a commencement date for warranties other than the date of Notice of Acceptance for the Work, or a designated portion of the Work, submit written warranties upon request of the Owner.
- B. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Owner within 15 days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by the Contractor, or the Contractor and a Subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the OWNER through the Owner's Representative for approval prior to final execution.
- D. Refer to individual Sections of Divisions 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.

E. Form of Submittal:

1. Prior to advertisement of Notice of Contractor's Settlement, compile 2 copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, Subcontractor, supplier or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
2. Bind warranties and bonds in heavy duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8.5" by 11" paper.
3. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the Installer.
4. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the Project title or name, and the name of the Contractor.
5. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION (Not applicable)

END OF SECTION 01 74 00

SECTION 01 78 00 - DEFINITIONS AND EXPLANATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification sections, apply to work of this section.

1.2 SUMMARY:

- A. Section Includes: Definitions of certain terms used in the specifications, and explanations of the language, abbreviations thereof, format and certain conventions used in the specifications and associated Contract Documents.
- B. Limitations of Scope: The definitions and explanations of this section are not necessarily either complete or exclusive, but are general for the work to the extent such definitions or explanations are not stated more explicitly in other provisions of the Contract Documents.

1.3 DEFINITIONS:

- A. The term "Owner" shall mean University of Colorado Colorado Springs.
- B. Project Manual: The term "Project Manual" refers to a bound, printed volume or volumes, which includes conditions of the Contract and the Specifications. It may also include bidding requirements, contract forms, details, schedules, surveys, reports or other relevant items which may or may not be Contract Documents.
- C. General Requirements: Provisions and requirements of other Division 1 Sections apply to the entire work of the Contract and, where so indicated, to other elements of work which are included in the Project.
- D. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on the drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements in the Contract Documents. Where terms such as "shown", "noted", "scheduled" and "specified" are used in lieu of "indicated", it is for the purpose of helping the reader accomplish the cross reference, and no limitation is intended except as specifically noted.
- E. Directed, Requested, etc.: Terms such as "directed", "requested", "authorized", "selected", "approved", "required", "accepted", and "permitted" mean "directed by the Owner's Representative", "requested by the Owner's Representative", etc. However, no such implied meaning will be interpreted to extend the Owner's Representative responsibility into the Contractor's area of construction supervision.
- F. Installer: The entity (person or firm) engaged by the Contractor or his Subcontractor or Sub-subcontractor for the performance of a particular element of construction at the project site, including installation, erection, application and similar required operations. It is a general requirement that Installers be expert in the operations they are engaged to perform.
- G. The term "experienced", when used with the term "Installer" means having completed a minimum of 5 successful previous projects similar in size and scope to this Project and means the Installer is familiar with the precautions required and has complied with requirements of the authorities having jurisdiction.

- H. Where the specifications require Installer experience or other qualifications, such requirements apply to the firm and not to its employees or individual members. Where firm ownership has changed after the required experience occurred, the Owner reserve the right to consider the ownership change as invalidating the experience requirements.
- I. Project Site: The space available to the Contractor for the performance of the Work, either exclusively or in conjunction with others performing other work as part of the project. The extent of the project site is shown on the drawings, and may or may not be identical with the description of the land upon which the project is to be built.
- J. Testing Laboratory or Agency: An independent entity engaged to perform specific inspections or tests of the work, either at the project site or elsewhere; and to report and (if required) interpret the results of those inspections or tests.
- K. Approve: Where used in conjunction with the Owner's Representative action on the Contractor's submittals, applications and requests, is limited to the Owner's Representative responsibilities and duties as specified in the General and Supplementary Conditions. Such approval shall not release the Contractor from responsibility to fulfill requirements of the Contract Documents, unless otherwise provided in the Contract Documents.
- L. Regulation: The term "Regulations" includes laws, statutes, ordinances and lawful orders issued by authorities having jurisdiction, as well as rules, conventions and agreements within the construction industry that control performance of the Work, whether they are lawfully imposed by authorities having jurisdiction or not.
- M. Contractor's Option: Where materials, products, systems or methods are specified to be at the Contractor's option, the choice of which material, method, product or system will be used is solely the Contractor's. There will be no change in Contract Sum or Time because of such choice.
- N. Furnish: The term "furnish" is used to mean, "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations".
- O. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations".
- P. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use".
- Q. Guarantee: The narrow definition of the term "warranty" is hereby established as applying to both "warranty" and "guarantee" which terms are used interchangeably.

1.4 SPECIFICATION EXPLANATIONS:

- A. General: This article is provided to help the user of these specifications to more readily understand the format, language, implied requirements and similar conventions of content. None of these explanations will be interpreted to modify the substance of the requirements.
- B. Specification Format: These specifications are organized and based on the CSI 16-Division format, including subdivision of the Divisions into Sections generally conforming to CSI "Masterformat" for section titles and numbers.

- C. Imperative Language: Imperative language is used generally in the specifications. Requirements expressed imperatively are to be performed by the Contractor. At certain locations in the text, for clarity, contrasting subjective language is used to describe the responsibilities which must be fulfilled either indirectly by the Contractor or, when so noted, by others.

1.5 SPECIFICATION CONTENT CONVENTIONS:

- A. Overlapping Requirements: Where compliance with two or more industry standards or sets of requirements is specified, and overlapping of those requirements also establishes different or conflicting minimums or levels of quality, the more stringent requirement will be enforced unless the Contract Documents specifically indicate otherwise.
- B. Refer apparently equal but different requirements and uncertainties as to which level of quality is required to the Owner's Representative for decision before proceeding.
- C. In certain circumstances language used in specifications and other Contract Documents is of the abbreviated type. Implied words and meanings will be appropriately interpreted. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where the full context of the Contract Documents so indicates.
- D. Specialists: In certain circumstances the specification requires or implies that specific elements of the Work be assigned to specialists or expert entities who must be engaged to perform that element of the work. Such assignments are special requirements over which the Contractor has no choice or option. They are intended to establish which party or entity involved in a specific element of the Work is considered as being sufficiently experienced in the indicated construction processes or operations to be recognized as "expert" in those processes or operations. Nevertheless, the ultimate responsibility for fulfilling all contract requirements remains with the Contractor.
- E. These requirements should not be interpreted to conflict with the enforcement of the building codes and similar regulations governing the Work. They are also not intended to interfere with local trade union jurisdictional settlements and similar conventions.
- F. Trades: The use of certain titles such as "carpentry" in the specification is not intended to imply that the work must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter". It also is not intended to imply that the requirements specified apply exclusively to tradepersons of that corresponding generic name.

1.6 DRAWING SYMBOLS:

- A. Graphic symbols used on the Drawings are those recognized in the construction industry for purposes indicated. Where not otherwise noted, symbols are defined by "Architectural Graphic Standards", published by John Wiley & Sons, Inc., seventh edition.
- B. Mechanical/Electrical Drawings: Graphic symbols used on mechanical and electrical Drawings are generally aligned with symbols recommended by ASHRAE. Where appropriate, they are supplemented by more specific symbols recommended by technical associations including ASME, ASPE, IEEE and similar organizations. Refer instances of uncertainty to the Owner's Representative for clarification before proceeding.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01 78 00

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes basic materials and methods that may be common to two or more sections of Division 23.

1.2 SUMMARY

- A. This Section includes the following basic mechanical materials and methods.
1. Piping hangers and supports
 2. Beam Clamps
 3. Electrical equipment
 4. Identification and labels
 5. Fire Stop Materials

1.3 SCOPE

- A. The work covered by this Division of the Project Specifications consists of furnishing all labor, supervision, equipment, materials, incidentals, and appurtenances, and performing all operations as necessary to complete the installation of Division 23 work in strict accordance with this Division of the Project Specifications and as indicated on the Project Drawings.

1.4 RELATED WORK SPECIFIED ELSEWHERE

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of these Specifications and shall be used in conjunction with this Division as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Contractors shall be responsible for and be governed by all requirements thereunder.
- B. Related Sections:
- | | |
|--|------------------|
| 1. Common Work Results for HVAC Systems | Section 23 05 00 |
| 2. Valves and Piping Components for HVAC Systems | Section 23 05 23 |
| 3. Testing Adjusting and Balancing | Section 23 05 93 |
| 4. HVAC Ducts and Casings | Section 23 31 00 |

1.5 WORK NOT INCLUDED

- A. Painting except as otherwise specified within this Division.
- B. Electric equipment and wiring except as otherwise specified within this Division.
- C. Lintels over wall openings.
- D. Framing around openings and chases.
- E. Concrete equipment pads or bases except concrete fill for vibration isolation bases.
- F. Installation of access panels in materials other than sheet metal.
- G. Cutting and patching of new and existing work.

1.6 QUALITY ASSURANCE

- A. Chemical and physical properties of all materials, design, performance characteristics and methods of construction of all items of equipment shall be in accordance with the following applicable regulations, references and standards of current editions in effect 30 days prior to receipt of bids:
 - 1. Air Movement and Control Association, Inc. (AMCA)
 - 2. American National Standards Institute (ANSI)
 - 3. Air Conditioning and Refrigeration Institute (ARI)
 - 4. American Society of Heating, Refrigerating, Air Conditioning Engineers (ASHRAE)
 - 5. American Society of Mechanical Engineers (ASME)
 - 6. American Society for Testing and Materials (ASTM)
 - 7. American Water Works Association (AWWA)
 - 8. Cast Iron Soil Pipe Institute (CISPI)
 - 9. Environmental Protection Agency (EPA)
 - 10. Factory Insurance Association (FIA)
 - 11. Factory Mutual Laboratories (FM)
 - 12. Manufacturers Standards Institute (MSI)
 - 13. National Electrical Manufacturer's Association (NEMA)
 - 14. National Fire Protection Association (NFPA)
 - 15. Plumbing and Drainage Institute (PDI)
 - 16. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
 - 17. Underwriters' Laboratories, Inc. (UL)
- B. All work, materials and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the latest published version of the following codes:
 - 1. International Building Code (IBC)
 - 2. International Fire Code (IFC)
 - 3. National Electric Code (NEC)
 - 4. National Fire Code (NFC)
 - 5. Occupational Safety and Health Act (OSHA)
 - 6. International Mechanical Code (IMC)
 - 7. International Plumbing Code (IPC)
 - 8. Applicable state and local codes
 - 9. Safe Drinking Water Act Amendment (SDWAA) 1988

- C. Comply with ASME A13.1, "Scheme for the Identification of Piping Systems" for lettering size, length of color field, colors, and viewing angles of identification devices.

1.7 DEFINITIONS

- A. "Furnish" shall mean the Contractor will purchase and deliver to the site the referenced piece of equipment.
- B. "Install" shall mean the Contractor will connect the referenced piece of equipment so it is complete, fully functional and ready for operation.
- C. "Provide" shall mean the Contractor will furnish and install the reference piece of equipment.
- D. "Contractor" shall mean the Contractor performing all work associated with this Division, except the Temperature Control System.
- E. "Control Contractor" shall mean the Contractor performing the work associated with the Temperature Control System.
- F. "Mechanical" shall apply to all work performed under this Division of the Specifications.
- G. "Owner's Representative" shall mean the person representing the Owner of the project.
- H. "Project Specifications" are the construction specifications for this project.
- I. "Project Drawings" are the construction plans for this project.
- J. "Contract Documents" shall mean the Project Specifications and Drawings.
- K. "MSS" Manufacturers Standardization Society for the Valve and Fittings Industry.
- L. "Environmental air duct" shall mean any supply or return duct conveying heating, cooling, exhaust or outside air.
- M. "Kitchen hood duct" shall mean any duct conveying exhaust from a kitchen hood to the outdoors.
- N. "Laboratory fume hood duct" shall mean any duct conveying exhaust from a laboratory fume hood.
- O. "WOG" Water or Gas pressure.
- P. "EPDM" Ethylene-propylene-diene terpolymer rubber.
- Q. "TFE" Tetrafluoroethylene plastic.

1.8 CONTRACT DOCUMENTS

- A. The mechanical drawings are diagrammatic in character and do not necessarily indicate every required offset, valve, fitting, etc.

- B. All drawings relating to this project, together with these specifications, shall be considered in bidding and construction. The drawings and specifications are complementary, and what is called for in either of these shall be as binding as though called for by both. Should any conflict or omissions arise between the drawings and specifications, such conflict shall be brought to the attention of the Owner's Representative for resolution.
- C. Unless otherwise indicated, all equipment and performance data listed is for job site conditions (elevation 6,150 ft.).
- D. Drawings are not to be scaled.

1.9 MATERIALS AND MANUFACTURERS

- A. All materials and equipment shall be new, free of defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practice of the Industry.
- B. Certain materials and/or equipment in this specification are specified by manufacturer and catalog numbers. The design was based on the specified equipment and establishes a degree of quality, performance, physical configuration, etc. If the Contractor should elect to use equipment other than the equipment used as a basis for design but listed as "acceptable" in the specifications, he shall be responsible for space requirements, configuration, performance and changes in, bases, supports, vibration isolators, structural members, openings in structure and other apparatus that may be affected by its use.
- C. Contractor further agrees that if deviations, discrepancies, or conflicts between reviewed submittals and/or shop drawings and the Contract Documents are discovered after submittals and/or shop drawings are processed by the Owner's Representative, the Contract Documents shall control and shall be followed unless modified by addenda or change order.

1.10 SUBSTITUTION APPROVALS

- A. Equipment and/or materials manufactured by any one of the manufacturers listed in the Contract Documents shall be acceptable. Where no specific manufacturer is listed, a first-class item of cataloged manufacture shall be furnished.
- B. Prior Approvals: Refer to Section 01.
- C. Substitution Requests after Execution of Contract: If Contractor wishes to furnish or use a substitute item of material and/or equipment, he must submit a change order request to the Owner's Representative. The request for change order shall itemize each of the proposed substitutions identified by applicable specification section, paragraph number and/or drawing number. A price change (increase or decrease) shall be listed for each item along with complete data showing performance over entire range, physical dimensions, electrical characteristics, material construction, operating weight and other applicable data. The change order request will be reviewed for equality, suitability and reasonableness of price differential. A single substitution change order listing the approved items will be issued with the net cost of the change order being the sum of the approved item costs. No subsequent substitution change orders will be considered. The Owner's Representative's decision will be final.
- D. It shall be the responsibility of the Contractor to assure that the substitute material and/or equipment fits into the space provided and the Contractor shall pay for all extra costs incurred by other trades for any and all changes necessitated by these substitutions.

1.11 SUBMITTALS

- A. All Section 23 product submittals shall be provided in the manner detailed below regardless of description provided elsewhere in the Contract Documents.
- B. Contractor agrees that shop drawings and/or submittals processed by the Owner's Representative are not change orders. The purpose of shop drawings and/or submittals is to inform the Owner which equipment and materials the Contractor intends to provide.
- C. Submittals and/or shop drawings are to be edited to show only specific data for the mechanical equipment that the Contractor intends to provide.
- D. Submittals and/or shop drawings are to be identified with equipment tags identical to those listed in the Contract Documents.
- E. All shop drawings for special systems (fire protection, temperature controls, etc.) that will become permanent record documents shall be prepared on sheets of 4-mil mylar of the same size as the Project Drawings.
- F. Provide submittals for all products the Contractor intends to use on this project and listed in Part 2 of this Division's Specifications.
- G. Submittals: All Section 23 product submittals shall be provided in the manner detailed below regardless of description provided elsewhere in the Contract Documents.
 - 1. All product submittals shall be provided to the Owner's Representative in a single three ring binder. Each copy of the product submittal shall be provided in an individual three ring binder. Each binder shall be white with a clear vinyl cover and contain three metal rings.
 - 2. Each binder shall be appropriately sized for the number of product submittals.
 - 3. Each binder shall contain a cover sheet with the project name, Contractor's name and submittal date.
 - 4. Each binder shall contain dividers which divide the product submittals into sections matching the specification sections. A table of contents identifying each section shall be included in the front of each binder.
 - 5. The Owner's Representative will provide two (2) reviews of the product submittals. If after two (2) reviews the submittals are not in compliance with the Contract Documents, the Contractor shall be responsible for compensating the Owner for additional submittal reviews. Compensation shall consist of shipping and delivery costs, hourly wages and other costs incurred during the additional services submittal review.
- H. Shop Drawings: Provide detailed drawings indicating mechanical equipment, piping and sheetmetal systems and components, and the spatial relationship of mechanical systems and equipment with other systems, equipment, and building components. Indicate requirements for equipment installation and all access and maintenance space required. Shop drawings shall be prepared on sheets matching the sheet size and scale of the Contract Documents. Shop drawings for mechanical rooms shall be at 1/4"=1'-0". Include the following in all shop drawings:
 - 1. Planned hydronic and plumbing piping layout, including valve and specialty locations and valve-stem movement.
 - 2. Planned sheetmetal layout including balance dampers, fire dampers, fire/smoke dampers, fittings, access panels, grilles, and diffusers.
 - 3. All equipment connected to the piping or sheetmetal system including all maintenance access and clearances for each piece of equipment.
 - 4. Equipment and accessory service connections and support details.
 - 5. Exterior wall and foundation penetrations.
 - 6. Fire-rated wall and floor penetrations.

7. Sizes and location of required concrete pads and bases.
8. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
9. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall prepare an operation and maintenance manual which shall cover all systems and equipment installed under Division 15.
- B. Refer to Section 01 for general requirements.
- C. Operation and maintenance manuals shall be provided at the completion of the construction. Submit three copies of the operation and maintenance manual to the Owner's Representative for review at least two weeks prior to the substantial completion site visit. Failure to provide the operation and maintenance manuals two weeks before the substantial completion site visit will result in delaying the site visit until the manuals are received and reviewed.
- D. Each operation and maintenance manual shall be indexed and contain the following information.
 1. Contractors' names, addresses and telephone numbers.
 2. Alphabetical list of all system components with the name and address and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
 3. Guarantees and warranties for all equipment whenever applicable.
 4. All manufacturers' data applicable to the installed equipment, including:
 - a. Approved shop drawings
 - b. Installation instructions
 - c. Lubrication instructions
 - d. Wiring diagrams
 5. A simplified description of the operation of all systems including the function of each piece of equipment within each system. These descriptions shall be supported with a schematic flow diagram when applicable.
 6. Temperature control diagrams including an explanation of the control sequence of each system along with the following instructions.
 - a. Emergency procedures for fire or failure of major equipment.
 - b. Normal starting, operating and shutdown modes of operation.
 - c. Summer or winter shutdown procedures.
 7. Approved Testing, Adjusting and Balancing report.
 8. Valve tag list when applicable.
 9. An outline of a preventative maintenance program for each system which shall include a schedule of inspection and maintenance. It shall suggest the maintenance and inspection operations that should be performed by the Owner and the operations that should be performed by contractors.
- E. Each Operation and maintenance manual shall be provided in the manner detailed below regardless of description provided elsewhere in the Contract Documents.
 1. Each manual shall be provided to the Owner's Representative in a single three ring binder. Each copy of the manual shall be provided in an individual three ring binder. Each binder shall be white with a clear vinyl cover and contain three metal rings.
 2. Each binder shall be appropriately sized for the information contained in the manual.
 3. Each binder shall contain a cover sheet with the project name, Contractor's name and submittal date.
 4. Each binder shall contain dividers that divide the manual into sections matching the information sections listed above. A table of contents identifying each section shall be included in the front of each binder.

1.13 WORKMANSHIP

- A. The appearance of the finished work shall be of equal importance with its mechanical efficiency. All work shall be done in accordance with acceptable commercial practices.
- B. Furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, plumbers, fitters, metal workers, welders, helpers, and labor required to unload, transfer, erect, connect-up, adjust, start, operate, and test each system.

1.14 SAFETY AND HEALTH REQUIREMENTS

- A. These Construction Documents and the construction hereby contemplated are to be governed at all times by applicable provisions of the "Williams-Steiger Occupational Safety and Health Act of 1970, Public Law 91-596" and the latest amendments thereto.

1.15 QUIET OPERATION AND VIBRATION

- A. Mechanical equipment provided under this contract shall operate under all load conditions without sound or vibration which is objectionable in the opinion of the Owner's Representative. In case of moving machinery, sound or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Owner's Representative shall be corrected in an approved manner by the Contractor at his expense. Vibration control shall be by means of approved vibration eliminators in a manner as recommended by the manufacturer of the eliminators.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pipe Hangers and Supports:
 - 1. B-Line Systems, Inc.
 - 2. Grinnell Corp.
 - 3. Michigan Hanger Co., Inc.
- B. Channel Support Systems:
 - 1. B-Line Systems, Inc.
 - 2. Grinnell Corp.; Power-Strut Unit.
 - 3. Michigan Hanger Co., Inc.; O-Strut Div.
 - 4. Unistrut Corp.
- C. Identification and Labels:
 - 1. Seton Corp.
 - 2. Brady Co.
 - 3. Mechanical Identification
 - 4. Brimar Industries
- D. Fire Stop Materials:
 - 1. 3M
 - 2. Johns Manville
 - 3. Specified Technologies Inc.
 - 4. Hilti

- E. Variable Frequency Drives:
 1. ABB
 2. Or Pre Approved Equal

2.2 HANGERS AND SUPPORTS

- A. Hangers:
 1. Uninsulated pipe 2" and smaller: Adjustable steel swivel ring hanger, MSS-SP69 (Type 10)
 2. Uninsulated pipe 2 1/2" and larger: Adjustable steel clevis hanger, MSS-SP-69 (Type 1)
- B. Hangers for steel piping shall be zinc-plated and hangers for copper piping shall be copper-plated. Hangers for insulated pipe shall be oversized to accommodate pipe insulation thickness.
- C. Vertical risers shall be supported at each floor line with steel riser clamps, MSS-SP-69 (Type 8); carbon steel for steel and cast iron pipe, copper electroplate or plastic coating for copper pipe.
- D. Except where governed by more stringent local codes, maximum hanger spacing and minimum hanger rod sizes shall comply with Table 1.

TABLE 1

Pipe Material	Pipe Size	Max. Hanger Spacing	Min. Hanger Rod Diameter
Copper, Types K, L, M, and DWV	1/2"	5'-0"	3/8"
	3/4"	5'-0"	3/8"
	1"	6'-0"	3/8"
	1 1/4"	7'-0"	3/8"
	1 1/2"	8'-0"	3/8"
	2"	8'-0"	3/8"
	2 1/2"	9'-0"	1/2"
	3"	10'-0"	1/2"
	3 1/2"	11'-0"	1/2"
	4"	12'-0"	1/2"

Note: Maximum hanger spacing shown in Table 1 is based on a maximum sag of 0.1" between hangers for straight pipe. Hanger spacing must be reduced to compensate for any valves and/or fittings installed in the pipe run. Spacing shall limit sag to 0.1" between hangers. Minimum hanger spacing for fire suppression piping shall be per appropriate NFPA requirements.

- E. Multiple pipe runs may be supported on trapeze hangers with pipe roller support. Hanger rods shall be one size larger than size specified herein for largest pipe on trapeze. Where trapeze length exceeds 42", an additional hanger rod shall be installed at mid-span.

2.3 BEAM CLAMPS

- A. Beam clamps shall be used where piping is to be suspended from building structural steel. Clamp type shall be as recommended by manufacturer based upon load to be supported and load configuration. C-clamps shall have lock nuts, cup point set screw, and restraining strap.

2.4 ELECTRICAL EQUIPMENT

- A. All electrical equipment shall conform to the electrical specifications and shall be suitable for operation on the voltage and phase available at the building site. These characteristics shall be verified with the Electrical Contractor prior to ordering equipment.
1. References:
 - a. NEMA Standard MG 1: Motors and Generators
 - b. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies
 - c. NEMA Standard 250: Enclosures for Electrical Equipment
 - d. NEMA Standard KS 1: Enclosed Switches
 - e. NFPA 70: National Electrical Code
 2. Electrical components and materials shall be UL listed for intended use.
 3. This Contractor shall furnish all electrical motors, starters, disconnects, and controls required for Section 23 equipment unless specifically noted otherwise elsewhere.
- B. All mechanical motors (except as noted) shall conform to the following specifications:
1. 1/2 hp and smaller shall be single-phase, permanent-split capacitor or split phase. Shaded pole motors are not acceptable without prior approval. Integral thermal overload protection.
 2. Larger than 1/2 hp shall be three-phase, except where specifically noted otherwise.
 3. Motor Construction:
 - a. NEMA Standard MG 1, 1993, general purpose, continuous duty, Design "B," except "C" where required for high starting torque.
 - b. Copper windings, 40°C ambient with Class F insulation, Class B temperature rise at 100% load, unless otherwise noted.
 - c. Two-speed, three-phase motors shall have two separate windings.
 - d. Frames: NEMA standard as required by application.
 - e. Bearings:
 - 1) Ball or roller bearings with inner and outer shaft seals; minimum 40,000-hour L-10 life.
 - 2) Permanently sealed except regreasable for 360 T and larger frames.
 - 3) Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
 - 4) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
 - f. Enclosure Type:
 - 1) Open drip-proof motors for indoor use where satisfactorily housed and properly ventilated during operation.
 - 2) Weather protected Type I for outdoor use when enclosed or housed with adequate ventilation, or TEFC when exposed to weather or moist locations.
 - 3) Special enclosures required for hazardous areas (XP, etc.) per equipment schedules. XP motors shall be UL listed.
 - g. Starting Capability: Frequency of starts not less than NEMA standard (two cold and one hot starts per hour).
 - h. Service Factor: 1.15 for three-phase motors and 1.35 for single-phase motors, except 1.0 for inverter-rated motors.
 - i. Noise Rating: NEMA standard (90 dba maximum for two-pole, 85 dba maximum for four or more poles).
 - j. Motor Connections: Flexible conduit, except where plug-in electrical cords are specifically indicated or furnished as OEM with equipment.
 4. Motor Efficiency:
 - a. All 230/460V, three-phase T-frame, single-speed, non-inverter duty motors 1 to 200 hp shall be energy-efficient type as defined in the Federal Energy Policy Act (EPACT 92). Minimum efficiencies shall be per the following table:

**PREMIUM FULL-LOAD EFFICIENCY
EPACT 92 (NEMA STD. MG1, TABLE 12-6C)**

No. of Poles →	ODP			TEFC		
	6	4	2	6	4	2
<u>Motor HP</u>						
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0

- b. All other three-phase motors shall be premium efficiency type as defined in NEMA Standard MG 1-1993, Part 12, Paragraph MG 1-12.58. Nameplate efficiency shall be equal to or greater than "nominal efficiency" values given in Table 12-10.
 - c. Exceptions: Direct-drive motors 5 hp or less, furnished OEM on in-line and/or vertical pumps, condenser fans, furnaces, and other direct-drive applications. These motors shall be high-efficiency type whenever available from the manufacturer.
5. Motor Selection Criteria:
- a. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
 - b. Motor sizes shall be large enough that the driven load will not require the motor to operate in the service factor range at selected conditions $\pm 20\%$. Minimum horsepower ratings shall be shown or scheduled on the drawings.
 - c. Motors shall be selected so that operating limits (temperature rise, service factor, etc.) are not exceeded at operating altitude and rated load.
 - d. Pump motors shall be "non-overloading"; i.e. shall not operate in service factor at any point on pump curve.
6. Motor Submittal Data: The following data shall be submitted for all motors:
- a. Full load current and service factor running current at operating voltage.
 - b. Locked rotor current, starting power factor, and power factor at full load.
 - c. Efficiency at full load.
 - d. Data to substantiate Class F insulation with Class B rise at 100% load.
 - e. Capacitor size (KVAR) for maximum power factor correction at 95% lagging.
 - f. Synchronous and full load speeds (rpm).
 - g. Enclosure type (ODP, TEFC, EXP, TENV, WPI, etc.)
 - h. All tests (except locked rotor current) shall be made at full voltage and rated frequency.
- C. Furnish individual combination type full NEMA rated starters with HMCP for all motors provided (except for starters that are shown to be provided with packaged equipment or in motor control centers). All combination starters shall be adequately braced for the fault current available. 42,000 AIC @ 480V, three-phase and 65,000 AIC @ 208V, three-phase shall be the minimum ratings.
- 1. Enclosures: NEMA Type 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA Type 3R with conduit hubs, or units in hazardous locations that shall have NEC proper class and Division XP enclosure.

2. All starters for three-phase motors shall be magnetic complete with the following accessories.
 - a. Three-leg Class 10 trip-free overload protection with externally operated manual reset and visual trip indicator
 - b. Separate three-phase voltage monitor to provide quick-trip on single phasing or phase reversal, automatic reset
 - c. Control transformers with fused primary and secondary
 - d. 120-volt holding coils
 - e. Integral Hand-Off-Auto switch for single-speed motors
 - f. Integral High-Low-Off-Auto switch for two-speed starters
 - g. High to low speed compelling time delay relay for two-speed starters
 - h. Auxiliary contacts, one N.O. and one N.C. minimum
 - i. "Run" pilot light
 3. Two-speed, two-winding starters shall incorporate both mechanical and electrical interlocks between the high and low speed contactors and shall have individual overload current protection and auxiliary contacts for each speed.
 4. Starters for single-phase motors shall be horsepower rated thermal overload switches.
 5. All starters shall be full NEMA rated. IEC rated and/or NEMA equivalent rated starters are not acceptable. All starters shall be listed and labeled by NEMA, UL, and CSA.
 6. Provide complete submittal data for all single and three-phase starters.
 7. Approved manufacturers are Allen-Bradley, Cutler-Hammer, General Electric, Square D, and S & S.
- D. Furnish all necessary control devices such as speed controls, transformers, and relays as required for proper operation of all equipment furnished under this Division.
- E. Furnish all remote switches and/or push-button stations required for manually operated equipment complete with low energy pilot lights of an approved type.
- F. Motors, starters, and other electrical control equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas.
- G. Furnish circuit and purpose identification for each remote manual switch and/or push-button station furnished herein. Identification may be either engraved plastic sign for permanent mounting to wall below switch, or stamping on switch cover plate. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

2.5 IDENTIFICATION AND LABELS

- A. All ductwork, piping, valves, controls, and equipment on the project shall be identified as specified herein. All identification shall be easily visible from the floor or usual point of vision. All lettering, sizes, and colors shall comply with ANSI Standard. A13.1, unless more stringent criteria are indicated below.
- B. Each piece of equipment shall have a metal permanently fastened equipment nameplate provided by the equipment manufacturer with data engraved or stamped. Provide the manufacturer's name, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data. The equipment nameplate shall be visible, accessible, and not covered with insulation.
- C. Each manual and control valve shall be identified with a 1 1/2" round brass tag, stamped or engraved with 1/4-inch lettering. Each tag shall be securely fastened to each valve with a brass bead chain or S-hook fastener.

- D. Provide 1/16-inch thick, engraved plastic-laminate marker for each access panel with abbreviated terms and numbers corresponding to concealed equipment and valves. Each marker shall have 1" high white letters on a black background.
- E. Provide 1/16-inch thick, engraved plastic-laminate marker for each piece of equipment with title as indicated on the Contract Documents and located in a position clearly visible from the floor. Each marker shall have 2" high white letters on a black background.
- F. Provide a wood or extruded aluminum framed valve schedule with 1/4" clear Plexiglas cover in each mechanical room. Each framed valve schedule shall be securely attached to the mechanical room wall.
- G. Controls: All controls and instruments shall be identified with labels mounted under the control or instrument.
 - 1. Labels for remote devices shall be metal tags or engraved plastic laminate with letters not less than 1/4" high.
 - 2. Labels for internal panel-mounted devices may be laminate adhesive-backed printed strips (Kroy, DuraType, or Brothers P-Touch 30) with 12-point or larger type or engraved plastic laminate. Door-mounted labels shall be engraved plastic-laminate with letters not less than 1/4" high and shall be screwed or riveted to the panel door.
- H. Time of Application: No identification shall be performed until all painting required under the project specifications has been accomplished.

2.6 FIRE STOP MATERIALS

- A. Material shall be UL listed for filling openings around ducts and/or pipes passing through fire rated walls and floors. Fire resistance ratings shall be by testing per ASTM E814.
 - 1. Caulk: Intumescent latex based no-sag elastomeric caulk designed as a through penetration fire stop system.
 - 2. Putty: Intumescent water based elastomeric hand formable putty designed as a through penetration fire stop system.
- B. All fire stop materials shall be installed per the manufacturer's UL Listed installation instructions. Provide all necessary sleeves and inserts required to meet the UL Listed installation instructions.

2.7 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS-SP-69 and MSS-SP-89. Install hangers, supports, clamps, and attachments as required by manufacturer's installation instructions to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping to be supported on field-assembled channel systems. Channel systems shall be assembled and installed according to manufacturer's installation instructions.
- C. Install hangers and supports complete with necessary inserts, beam clamps, bolts, rods, nuts, washers, and other accessories.
- D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

- E. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

2.8 VALVE TAGS

- A. Provide a valve tag for each valve and control device in the piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, faucets, hose bibs, and lawn-watering hose connections. List tagged valves in valve schedule.
- B. Each valve tag shall identify the normal position of the valve (N.O., N.C., etc.) and conform to the following numbering system:
 - 1. XXXXX-XXXX=Service – Valve Number. As an example, HWS-0001 is Heating Water Supply Valve number 1.

2.9 EQUIPMENT SIGNS AND MARKERS

- A. Install engraved plastic-laminate signs on each major piece of mechanical equipment. Include signs for the following general categories of equipment:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Fire department hose valves and hose stations.
 - 3. Meters, gages, thermometers, and similar units.
 - 4. Fuel-burning units, including boilers, furnaces, heaters, and absorption units.
 - 5. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - 6. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 - 7. Fans, blowers, primary balancing dampers, and mixing boxes.
 - 8. Air handling units, VAV boxes, and CV boxes.
 - 9. Tanks and pressure vessels.
 - 10. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

2.10 DELIVERY AND STORAGE OF MATERIALS

- A. Make provisions for the delivery and safe storage of materials and make the required arrangements with other Contractors for the introduction into the building of equipment too large to pass through finished openings.

2.11 MECHANICAL WIRING

- A. Provide all temperature control wiring, all interlock wiring, and equipment control wiring for the equipment that is to be provided under Section 23 unless specifically shown on electrical drawings. All wiring in return air plenums shall be plenum rated wiring in accordance with NFPA 90.
- B. All line voltage interlock and control wiring shall be not less than No. 14 insulated color coded wire in conduit or raceway. Conductors shall be labeled at both ends. All wiring in return air plenums shall be plenum rated wiring in accordance with NFPA 90.

2.12 MAINTENANCE MANUAL

- A. The Contractor shall prepare a maintenance manual which shall contain maintenance information for all systems and equipment installed under this Division. Refer to Division 1 for submittal requirements.
- B. The manual shall be indexed for each system and type of component and contained within a 3-ring hard cover binder. The binder shall be sized to hold all of the maintenance information. The Contractor shall cross out all references to equipment and options which were not installed on this project. Provide the following information.
 - 1. Contractors' names, addresses, and telephone numbers.
 - 2. Alphabetical list of all system components with the name, address and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
 - 3. Guarantees and warranties of all equipment whenever applicable.
 - 4. All manufacturers' data applicable to the installed equipment such as the following:
 - a. Approved shop drawings
 - b. Installation instructions
 - c. Lubrication and maintenance instructions
 - d. Wiring diagrams
 - 5. A simplified description of the operation of each system including the function of each piece of equipment. These descriptions shall be supported with a schematic flow diagram when applicable.
 - 6. Temperature control diagrams including an explanation of the control sequence for each system and the following instruction wherever applicable.
 - a. Emergency procedures for fire or failure of major equipment
 - b. Normal starting, operating and shutdown
 - c. Summer or winter shutdown
 - 7. System balancing report.
 - 8. Valve tag list when applicable.
 - 9. An outline of a preventative maintenance program for each system which shall include a schedule of inspection and maintenance. It shall suggest the maintenance and inspection that should be performed by the Owner and that which should be done using an outside service.

2.13 SCHEMATIC FLOW DIAGRAM

- A. Prepare a schematic flow diagram for each system showing all component parts including all main isolation valves. The schematic flow diagrams presented in the Contract Documents may be used for this purpose providing they are properly edited to reflect as-built conditions. Relate all valve tag numbers to this diagram where applicable.
- B. The schematic flow diagrams and the temperature control diagrams are to be wall mounted under 1/4" Plexiglas in an accessible location, in the main mechanical equipment room. Provide schematic control diagrams for all large air systems (5,000 cfm and above), boiler systems, chiller systems, and steam systems. Diagrams shall show all control points and components.

2.14 SURVEYS AND MEASUREMENTS

- A. Base all measurements, both horizontal and vertical, on established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

- B. If any discrepancy between actual measurements and those indicated is discovered which prevents following good practice or the intent of the Contract Documents notify the Owner's Representative and do not proceed until instructions are received from the Owner's Representative.

2.15 SCAFFOLDING, RIGGING, AND HOISTING

- A. Provide all scaffolding, rigging, hoisting, and services necessary for delivery, erection, and placement within the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

2.16 WATERPROOFING

- A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Owner's Representative before work is performed. Contractor shall furnish all necessary sleeves, caulking, and flashing required to make openings absolutely watertight.
- B. Flashing of all building penetrations to the outside shall be per applicable codes and standards. Refer to appropriate sections for acceptable materials and methods.

2.17 GUARDS AND RAILINGS

- A. Provide removable OSHA guards or railings for all belt drives and rotating machinery such as pumps. Railings shall be 1-1/2" pipe and railing fittings.

2.18 ESCUTCHEON PLATES

- A. Escutcheon plates shall be provided for all exposed uninsulated pipes passing through walls, floors, and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing through sleeves that extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

2.19 SLEEVES AND INSERTS

- A. The Contractor shall provide and locate all sleeves and inserts required before the floors and walls are built, or shall be responsible for the cost of cutting and patching required for pipes where sleeves and inserts were not installed or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers.
- B. Sleeves shall be provided for all mechanical piping passing through concrete floor slabs and concrete, masonry, tile, and gypsum wall construction. Sleeves in poured concrete that are to be flush with the finished surfaces shall be constructed of 24 Ga. galvanized sheet metal with lock seam joints. All other sleeves shall be constructed as follows unless otherwise indicated on the drawings.
 1. Sheet Metal Sleeves: 10-gauge galvanized sheet metal, round tube closed with welded longitudinal joint.
 2. Pipe Sleeves: Schedule 40 galvanized welded steel pipe, ASTM A53, Grade A.

- C. Sleeves in Exterior Walls Below Grade:
 1. Shall be Schedule 40 pipe per item 2 above.
 2. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates that cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
- D. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe only and the insulation shall be made to butt against the construction except for pipes requiring insulation having a vapor barrier, in which case the sleeves shall be large enough to pass the pipe and insulation. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following.
 1. Terminate sleeves flush with walls, partitions, and ceiling.
 2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
 3. In all areas where pipes are exposed, extend sleeves 1/4" to 1/2" above the finished floor, except in rooms having floor drains where the sleeves shall be extended 2" above the finished floor.
- E. Fasten sleeves securely in floors and walls, so they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials from being forced into the space between pipe and sleeve during construction.
- F. In all areas where ducts are exposed and ducts are passing through floor, the hole shall be surrounded by a 4"-high by 3"-wide concrete curb.
- G. Provide a man present with the General Contractor during the pouring of the concrete to make sure that the location of the sleeves is not disturbed during the pour.

2.20 HOLES IN PRECAST CONCRETE

- A. All openings in precast concrete over 6" square or 6" diameter shall be cast in place at the time of fabrication. The Mechanical Contractor shall cut all openings 6" and under at the site or shall make proper arrangements with the fabricator to cast same during fabrication. All openings if cut shall be cut with rotary-type drill, or other method as approved by the Owner's Representative. Holes cut with pneumatic hammer will not be accepted.

2.21 OLD PIPE LINES

- A. If any old sewer, water, gas, or other pipes are encountered that interfere with the proper installation of new work and that will not be used in connections with the new work, promptly advise the General Contractor and Owner's Representative.

2.22 SUPPORTING STEEL

- A. Provide structural steel framework for supporting mechanical equipment.
- B. All steel work shall be in conformance with the requirements of the AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings. Material shall conform to ASTM A36.
- C. Bases and supports shall be constructed as detailed on approved shop drawings provided by the Contractor.

- D. All structural steel shall receive one coat of industrial enamel primer in the shop after all fabrication welding is complete. Paint all field joints with one coat of industrial enamel primer. After all steel is properly primed, paint with two coats of exterior grade enamel. Color as selected by the Owner's Representative.

2.23 COORDINATION AND COOPERATION WITH OTHER TRADES

- A. The Contractor for this work shall examine the Contract Documents for other trades. If clearance or space conditions appear inadequate or if any discrepancies occur between his work and the work of others, he shall report such discrepancies to the Owner's Representative and shall obtain written instructions for any changes necessary to accommodate his work with the work of others. Any changes in the work covered by the Contract Documents made necessary by the failure or neglect of the Contractor to report such discrepancies shall be made by and at the expense of this Contractor.
- B. Where the mechanical work will be installed in close proximity to, or will interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the Owner's Representative, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'-0", clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make the necessary changes in his work to correct the condition without extra charge.

2.24 INSTALLATION

- A. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed in accordance with the recommendations of the manufacturer. Maintain maximum head room and space conditions at all points.
- B. Coordinate work with other trades prior to fabrication and installation of equipment, piping, and ductwork. Adjust ductwork and piping to fit into space available.

2.25 ACCESSIBILITY

- A. Locate all equipment that must be serviced, operated, or maintained in fully accessible positions. Equipment shall include, but not be limited to, valves, traps, clean-outs, motors, controllers, switchgear, and drain points. If required for accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility.

2.26 PAINTING

- A. Paint field-fabricated hangers and frames, unpainted equipment, and uninsulated exposed piping (interior and exterior) with one coat of primer and two coats of flat enamel paint, color as selected by Owner's Representative.

2.27 CLEANUP

- A. At the completion of work, all equipment on the project shall be checked and thoroughly cleaned including coils, plenums, under equipment and any and all other areas around or in equipment provided under this section. Clean all exposed surfaces of all piping, hangers, ducts, and other exposed metal of all grease, plaster, or other foreign material. Remove all stick-on labels and clean surfaces.

- B. At the completion of the work, remove from the building, the premises, and surrounding streets, alleys, etc., all rubbish and debris resulting from this project and leave all equipment spaces absolutely clean and ready for use.
- C. Any filters used during construction shall be replaced with new filters during final cleanup.

2.28 DAMAGED SURFACES

- A. At the completion of work, all mechanical equipment furnished under this contract shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet, jacket, or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

2.29 PROTECTION

- A. The Contractor shall protect all work and material from damage by his work or workmen, and shall be liable for all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until finally inspected, tested, and accepted; he shall protect work against theft, injury, or damage; and shall carefully store material and equipment received on site that is not immediately installed. He shall close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

2.30 RECORD OF CHANGES

- A. Refer to Division 1 for requirements.

2.31 RESPONSIBILITY OF CONTRACTOR

- A. The Contractor is responsible for the complete and satisfactory installation of the systems and equipment in accordance with the intent of the Contract Documents. As part of his work, he shall provide all incidental items necessary to provide a complete and operational system. He shall coordinate the installation of the multiple components and parts so that the completed system will function as intended by the Contract Documents. At the completion of the project, he shall provide a system with all components and parts adjusted and in proper working order.

2.32 VARIABLE FREQUENCY DRIVES

- A. Provide enclosed variable frequency drives suitable for operation at the current, voltage, and horsepower indicated on the schedule. Conform to requirements of NEMA ICS 3.1.
- B. VFD must operate, without fault or failure, when voltage varies plus 10% or minus 15% from rating, and frequency varies plus or minus 5% from rating.
 1. Displacement Power Factor: 0.98 over entire range of operating speed and load.
 2. Operating Ambient Temperature: -10 degrees C to 40 degrees C (14 degrees F to 104 degrees F)
 3. Humidity: 0% to 95% non-condensing.
 4. Altitude: to 3,300 feet, higher altitudes achieved by derating.
 5. Minimum Efficiency: 96% at half speed; 98% at full speed.
 6. Starting Torque: 100% starting torque shall be available from 0.5 Hz. to 60 Hz.

7. Overload capability: 110% of rated FLA (Full Load Amps) for 60 seconds; 180% of rated FLA, instantaneously.
- C. The VFD must meet the requirements for Radio Frequency Interference (RFI) above 7 MHz as specified by FCC regulations, part 15, subpart J, Class A devices.
- D. Total Harmonic Distortion (THD) compliance:
- E. VFDs must have a minimum short circuit rating of 65K amps RMS (100K amps RMS with a DC bus reactor) without additional input fusing.
- F. Design
1. VFD shall employ microprocessor based inverter logic, isolated from all power circuits.
 2. VFD shall include surface mount technology with protective coating.
 3. VFD shall employ a PWM (Pulse Width Modulated) power electronic system, consisting of:
 4. Input Section:
 - a. VFD input power stage shall convert three-phase AC line power into a fixed DC voltage via a solid state full wave diode rectifier, with MOV (Metal Oxide Varistor) surge protection.
 5. Intermediate Section:
 - a. DC bus as a supply to the VFD output Section shall maintain a fixed voltage with filtering and short circuit protection.
 - b. DC bus shall be interfaced with the VFD diagnostic logic circuit, for continuous monitoring and protection of the power components.
 - c. 30 HP to 150 HP @ 208 VAC, 30 HP to 150 HP @ 240 VAC, and 40 HP to 500 HP 480 VAC, VFDs shall include a DC bus reactor to minimize reflected harmonics.
 6. Output Section
 - a. Insulated Gate Bipolar Transistors (IGBTs) shall convert DC bus voltage to variable frequency and voltage.
 - b. The VFD shall employ PWM sine coded output technology to power the motor.
 7. The VFD must be selected for operation at carrier frequencies at or above 5 kHz without derating to satisfy the conditions for current, voltage, and horsepower as indicated on the equipment schedule. Exception to this requirement is allowed only for VFDs providing 506 amps or more.
 8. VFD shall have an adjustable carrier frequency: The carrier frequency shall have a minimum of six settings to allow adjustment in the field.
 9. VFD shall have embedded Building Automation System (BAS) protocols for network communications. These protocols shall be accessible via a RS-422/485 communication port.
 10. VFD shall have a quick disconnect removable control I/O terminal block to simplify control wiring procedures.
 11. VFD shall include two independent analog inputs. One shall be 0-10 VDC. The other shall be programmable for either 0-10 VDC or 4-20 mA. Either input shall respond to a programmable bias and gain.
 12. VFD shall include a minimum of seven multi-function digital input terminals, capable of being programmed to determine the function on a change of state. These terminals shall provide up to 30 functions, including, but not limited to:
 - a. Remote/Local operation selection
 - b. Detection of external fault condition
 - c. Remote Reset
 - d. Multi-step speed commands
 - e. Run permissive
 - f. Floating control
 13. VFD shall include two 0-10 VDC or 4-20 mA analog output for monitoring, or "speed tracking" the VFD. The analog output signal will be proportional to output frequency, output current, output power, PI (Proportional & Integral control) feedback or DC bus voltage.

14. VFD shall provide terminals for remote input contact closure, to allow starting in the automatic mode.
15. VFD shall include at least one external fault input, which shall be programmable for a normally open or normally closed contact. These terminals can be used for connection of firestats, freeze-stats, high pressure limits or similar safety devices.
16. VFD shall include two form "A" contacts and one form "C" contact, capable of being programmed to determine conditions that must be met in order for them to change state. These output relay contacts shall be rated for at least 5A at 120 VAC and shall provide up to 18 functions, including, but not limited to:
 - a. Speed agree detection.
 - b. Low and high frequency detection.
 - c. Missing frequency reference detection.
 - d. Overtorque/Undertorque detection
 - e. Drive Running
 - f. Drive Faulted
17. VFD shall include a power loss ride through of 2 seconds.
18. VFD shall have DC injection braking capability, to prevent fan "wind milling" at start or stop, adjustable, current limited.
19. VFD shall have a motor preheat function to prevent moisture accumulation in an idle motor.
20. VFD shall include diagnostic fault indication in selected language, last 10 faults storage and heatsink cooling fan operating hours.
21. VFD shall have a digital operator with program copy and storage functions to simplify set up of multiple drives. The digital operator shall be interchangeable for all drive ratings.
22. VFD shall include a front mounted, sealed keypad operator, with an English language (or one of 6 additional international languages) illuminated LCD display. The operator will provide complete programming, program copying, operating, monitoring, and diagnostic capability. Keys provided shall include industry standard commands for Hand, Off, and Auto functions.
23. VFD plain language display shall provide readouts of; output frequency in hertz, PI feedback in percent, output voltage in volts, output current in amps, output power in kilowatts, D.C. bus voltage in volts, interface terminal status, heatsink temperature and fault conditions. All displays shall be viewed in an easy-to-read illuminated LCD with International language selectability.
24. VFD unit shall include the following meters to estimate use of energy:
 - a. Elapsed Time Meter
 - b. Kilowatt Meter
 - c. Kilowatt Hour Meter
25. VFD shall include PI control logic, to provide closed loop setpoint control capability, from a feedback signal, eliminating the need for closed loop output signals from a building automation system. The PI controller shall have a differential feedback capability for closed loop control of fans and pumps for pressure, flow or temperature regulation in response to dual feedback signals.
26. An energy saving sleep function shall be available in both open loop (follower mode) and closed loop (PI) control, providing significant energy savings while minimizing operating hours on driven equipment. When the sleep function senses a minimal deviation of a feedback signal from setpoint, or low demand in open loop control, the system reacts by stopping the driven equipment. Upon receiving an increase in speed command signal deviation, the drive and equipment resume normal operation.
27. VFD shall include loss of input signal protection, with a selectable response strategy including speed default to a percent of the most recent speed.
28. VFD shall include electronic thermal overload protection for both the drive and motor. The electronic thermal motor overload shall be approved by UL. If the electronic thermal motor overload is not approved by UL, a separate UL approved thermal overload relay shall be provided in the VFD enclosure.
29. VFD shall include the following program functions:
 - a. Critical frequency rejection capability: 3 selectable, adjustable deadbands.
 - b. Auto restart capability: 0 to 10 attempts with adjustable delay between attempts.
 - c. Ability to close fault contact after the completion of all fault restart attempts.

- d. Stall prevention capability.
 - e. "S" curve soft start capability.
 - f. Bi-directional "Speed search" capability, in order to start a rotating load.
 - g. 14 preset and 1 custom volts per hertz pattern.
 - h. Heatsink over temperature speed fold back capability
 - i. Terminal status indication.
 - j. Program copy and storage in a removable digital operator.
 - k. Current limit adjustment capability, from 30% to 200% of rated full load current of the VFD.
 - l. Motor pre-heat capability
 - m. Input signal or serial communication loss detection and response strategy.
 - n. Anti "wind-milling" function capability.
 - o. Automatic energy saving function.
 - p. Undertorque/Overtorque Detection.
 - q. Preset speeds
30. VFD shall include factory settings for all parameters, and the capability for those settings to be reset.
31. VFD shall include user parameter initialization capability to re-establish project specific parameters
32. VFD shall include the capability to adjust the following functions, while the VFD is running:
- a. Speed command input.
 - b. Acceleration adjustment from 0 to 6000 seconds.
 - c. Deceleration adjustment from 0 to 6000 seconds.
 - d. Select from 5 preset speeds.
 - e. Analog monitor display.
 - f. Removal of digital operator.

END OF SECTION 23 05 00

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes general requirements for testing, adjusting, and balancing (TAB) of the environmental systems.

1.2 SUMMARY

- A. This section includes the following materials and methods.
1. General TAB Requirements
 2. Air system Balancing

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. The General Conditions of the Contract, Supplementary Conditions and General Requirements are a part of the Project Specification and shall be used in conjunction with this Division as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Contractors shall be responsible for and be governed by all requirements thereunder.
- B. Related Sections:
- | | |
|---|------------------|
| 1. Common Work Results for HVAC Systems | Section 23 05 00 |
| 2. Testing Adjusting and Balancing | Section 23 05 93 |
| 3. HVAC Fans | Section 23 34 00 |

1.4 QUALITY ASSURANCE

- A. Qualifications:
1. Pre-qualified TAB firms for this project are:
 - a. Midwest
 - b. Or Pre Approved Equal
 2. Other qualified firms desiring to furnish services for this project shall submit for written approval, during bid time, a brochure listing the qualifications of personnel in the organization, instruments available to be used, an outline of system balancing procedures that is intended to be followed, and a list of projects of similar size, scope and complexity successfully balanced within the last two years.

3. TAB firm shall:
 - a. Have had previous experience with at least one project of similar type and size within the State of Colorado. Provide the project(s) name, owner, general contractor, mechanical contractor, and references with phone numbers for each.
 - b. Have a permanent place of business and phone number within a 200-mile radius of the job site.
 - c. Have been actively engaged in balancing work within the State of Colorado for at least three of the past five years. Provide at least three project references with phone numbers.
4. The TAB field work shall be performed under the direct supervision of a registered Professional Engineer who has had at least five years of balancing experience in the state in which the work is being done or a NEBB or AABC certified TAB supervisor. The PE or certified supervisor may:
 - a. Perform the TAB work or be on-site at least 33% of the total time the TAB work is in progress, or
 - b. Be on site a minimum of 10% of the total time the TAB work is in progress with the work performed by a full-time certified TAB Technician who has been certified by the Sheet Metal Industry National Certification Board.

B. Certifications:

1. Testing, adjusting, and balancing shall be done by a firm using NEBB or AABC certified supervisors, or by an independent firm specializing in this work. A definition of independent shall mean the firm is not associated with the Mechanical Contractor performing work under Division 23; the firm derives its income solely from testing, adjusting, and balancing and/or commissioning mechanical systems, and the work is performed in a professional manner.
2. TAB firm shall own or rent and have available for this project all necessary balancing instruments as required to maintain NEBB or AABC certification. Instrument calibration shall have been checked and verified as per NEBB requirements. Provide instrument list with calibration date for each instrument listed.

C. Regulatory Requirements:

1. Refer to Section 23 05 00 for general code, standard and regulatory requirements.
2. Comply with procedural standards for testing, adjusting, and balancing of environmental systems as outlined in the latest edition of SMACNA, NEBB, and/or AABC procedural manuals.
3. Applicable sections and paragraphs as published in ASHRAE 2003 Applications Handbook, Chapter 34, Testing, Adjusting, and Balancing, and Standard 111-1988.

1.5 SUBMITTALS

- A. Submit proposed TAB forms and report formats to Owner or his representative for approval at least 120 days prior to commencing field work.
- B. Quality Assurance/Control Submittals:
 1. Within 30 days after contract award, submit the name(s) of the professional engineer and/or the NEBB or AABC certified supervisor who will be supervising this work. Submit the name(s) of the TAB technician(s) who will be performing the work.
- C. Closeout Submittals:
 1. TAB Report: After all balancing is complete, and all coordination with the Commissioning Contractor and the Owner or his representative is complete, the balancing firm shall furnish four bound reports which shall contain the following information:
 - a. Belt and drive sheave information as installed and as changed, fan nameplate information, motor nameplate information, and amperage and voltage to all motors in various operating modes where applicable. Also, maximum and minimum rpm settings on VFD units.
 - b. Static pressure drops across all components of the air systems. Static pressure profile for each air handling unit system.

- c. Required and final balanced cfm at each system terminal unit. Include the terminal size, inlet size, inlet static pressure, temperature, and velocities read to attain the required cfm.
 - d. Refrigerant system operating amperages, pressures, and temperatures.
 - e. Overload protection data for all motors shall be recorded. Starter and/or VFD brand, model, enclosure type, installed overload devices, original ratings and set points (and revised device ratings and set points when applicable) shall be recorded. If the starters and/or VFDs were furnished by the Mechanical Contractor, the overloads shall be verified and changed to the correct size when necessary, and so noted in the report. If the starters were furnished by the Electrical Contractor, the correct overload device sizes and settings shall be noted in the report and the Electrical Contractor shall be advised of all discrepancies.
 - f. The method of balance, the instruments used with calibration history, the project altitude, and any correction factors used in the calculations shall be reported.
 - g. A reduced set of drawings (11" x 17") shall be included in the report with all terminals, VAV boxes, air outlets, inlets, coils, unit heaters, fin tube loops, radiant panel loops, etc., clearly marked, all equipment designated, and all referenced to the device test reports. The contract drawings may be reduced and used for this purpose, if they remain legible.
 - h. The TAB Contractor shall submit bound copies of the final testing and balancing report to the Owner or his representative at least 15 days prior to the Mechanical Contractor's request for final inspection. All data shall be recorded on applicable reporting forms. The report shall include all operating data as previously listed, a list of all equipment used in the testing and balancing work, and shall be signed by the supervising registered engineer or certified TAB supervisor and certified TAB technician, and affixed with his certification seal. Final acceptance of this project will not take place until a satisfactory report is received.
2. Balance report shall not be submitted until all all improperly configured or installed systems are corrected and improperly installed or missing balance devices are corrected and tested reports submitted with incomplete information will be returned unreviewed.

1.6 SCHEDULING

- A. Coordinate scheduling of work with the General Contractor, the appropriate subcontractors.
 - 1. Schedule TAB work to coincide with testing and verification of control systems where practical.
- B. Provide written notification within 24 hours to the General Contractor, Engineer, and Owner's Representative of any component and/or system deficiencies.

1.7 RETAINAGE

- A. Contract payment retainage may be withheld against the General Contractor until the final completion of this section of work has been demonstrated by the submission of the TAB report, and an evaluation of its contents has been made by the Owner's Representative.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Provide all necessary tools, scaffolding, and ladders.

- B. Provide all necessary instruments. Calibration and maintenance of instruments shall be in accordance with SMACNA, NEBB, AABC, and/or the manufacturer's standards and recommendations.
 - 1. Calibration histories for each instrument shall be available for examination.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Air testing and balancing shall not begin until the system to be tested has been cleaned and is in full working order.
- B. Preliminary TAB requirements shall be ascertained prior to the commencement of work through a review of available plans and specifications for the project. In addition, visual observations at the site during construction shall have been made to determine the location of required balancing devices, that they are being installed properly, and acceptable access is provided.
- C. Prior to and during testing and balancing, TAB contractor shall immediately notify the Contractor of all balancing devices not yet installed and those portions of the system unable to be balanced. The Contractor shall correct the deficiencies and shall notify the Engineer of situations requiring additional instruction.
- D. Before any air balance work is done, the system shall be checked for:
 - 1. Excessive duct leakage
 - 2. Dirt and debris in ducts and/or AHUs
 - 3. Filters are installed (and changed if they are dirty)
 - 4. Coil fins are clean and combed where needed
 - 5. Correct motor rotation
 - 6. Excessive vibration
 - 7. Equipment lubrication
 - 8. Proper operation of automatic control and smoke dampers
 - 9. Manual control dampers, fire dampers, and air outlet dampers are wide open
 - 10. Duct end caps installed and access doors closed
 - 11. Grilles, registers, and diffusers are properly installed
- E. Put heating, ventilating, and air conditioning systems and equipment into full operation and continue operation of same during each working day of testing and balancing.

3.2 REQUIREMENTS OF WORK

- A. Adjust air handling systems to the following tolerances:
 - 1. Supply systems shall be balanced so that:
 - a. The total quantity of each fan is within -5% to +5% of design values.
 - 2. Exhaust and return systems shall be balanced so the total quantity of each fan is -5% to +5% of design values.

B. Air Balance:

1. Air supply, return, and exhaust systems with air quantities for each air device.
 - a. Air handling units including supply, return, mixed, and outside air temperatures
 - b. Fan data including cfm, static pressure, fan rpm, motor running amperage; (and full load amperage) before and after final balance.
2. The supply, return, and exhaust fan static pressures shall be set by the balancing firm (and the Controls Contractor if the systems have fan volume control).
 - a. The supply air system shall be tested in all operating modes (full return air, full outside air, full cooling with the design diversity, and full cooling with no diversity).
 - b. After balancing is completed, check fan motor amperage with the filters clean.
 - c. System static pressure profiles and fan motor amperages shall be recorded in all modes.
 - d. The lowest fan speed resulting in satisfactory system performance shall be determined at full design delivery. Any inlet or outlet fan volume (balancing) dampers shall be in the wide-open position and one path presenting the greatest resistance to flow shall be fully open and unobstructed.
 - e. After balancing, all adjustable speed sheaves 7-1/2 hp and larger shall be replaced with fixed-speed sheaves by the TAB Contractor.
3. Provide system static pressure profiles which identify pressure differences across all components of air handling units and built-up systems. Pressure drops shall be individually measured and recorded for intake and exhaust vents, hoods, louvers, manual and auto control dampers, filters, coils, evap. coolers, fans, terminal units, etc.
 - a. On systems with OSA economizers, pressure drop values shall be recorded for both minimum and 100% OSA modes.
 - b. On multi-zone air handlers, all zone dampers shall be checked for excessive leakage at both full heat and full cool positions. Manual zone balance dampers shall then be set. Correct location and operation of zone thermostats shall be verified.
4. Building static pressure adjacent to entries shall be measured and recorded. Adjust systems to maintain a positive pressure of 0.05-inch w.c. when possible. Note any discrepancies.
5. Final adjustments shall include but not be limited to the following:
- 6.

ITEM	ADJUSTMENT
Fan: VFD Drive	<p><u>VFD</u>: Coordinate VFD startup with Section 15170 vendor. Adjust maximum and minimum rpm settings as necessary to obtain design cfm. Verify that ramp-up and down adjustments are made as necessary to prevent overshoot and "hunting."</p> <p>Verify that overload trip settings are properly adjusted as necessary to protect the motor. Provide sheave and belt exchange if necessary to prevent motor overload at "system wide-open" condition.</p>
Fan: Belt Drive	<p><u>RPM</u>: Include sheave and belt exchange as required to deliver air flow within limits of installed motor horsepower and mechanical stress limits of the fan. Determine the limiting fan tip speed before increasing rpm. Final fan speed setting shall allow for predicted filter loading and shall provide proper duct pressures for operation of zone cfm regulators where used.</p> <p><u>Note</u>: Fan rpm shall not be increased more than 10% from the factory setting without prior authorization by the Engineer.</p>
Outside Air	<p><u>Manual Dampers</u>: Adjust manual dampers (and/or OSA fan capacity) as necessary to obtain design OSA cfm.</p> <p><u>Automatic Dampers</u>: Adjust the maximum open position of separate minimum OSA dampers (or the minimum open position of economizer OSA dampers) as necessary to obtain design minimum OSA cfm.</p> <p><u>Quantity of OSA</u>: Shall be measured directly using a velocity traverse</p>

ITEM	ADJUSTMENT
	(or pitot tube traverse when separately ducted), or shall be calculated using return air, OSA, and resultant mixed air temperatures.
Motor Starter - Overload Trip Devices	<u>Mechanical Contractor Furnished VFD, Magnetic, and Manual Starters:</u> Exchange or reset overload devices as required for proper motor protection. <u>Electrical Contractor Furnished Motor Control Center Magnetic Starters:</u> Check overload devices for correct sizing and/or setting. Notify the Electrical Contractor of any discrepancies.

7. When air balancing is done and manual dampers are set, all test holes shall be plugged and all manual damper positions shall be marked. The following information shall be recorded in the final report: Design inlet or outlet size, actual inlet or outlet size, and design cfm (velocity) through the orifice for each terminal in the system.
- C. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.3 FIELD QUALITY CONTROL

- A. Upon request of the Engineer, a representative of the balancing firm performing the work shall demonstrate to him fluid flow quantities shown in the report by reading back outlets or terminals selected at random by the Engineer. It is understood that the operating mode of the system shall be the same for readback as it was during balancing, and the number of readings verified will not exceed 10% of the total in the report.
- B. When deemed necessary by the Owner's Representative or Engineer, the balancing firm shall run temperature, pressure, and/or humidity recordings, and shall be prepared to verify any of the report test results in the presence of the Owner's Representative and/or Engineer when requested.
- C. When deemed necessary by the Engineer, a 24-hour space temperature recording shall be taken and any required partial rebalance of the system shall be performed without any additional cost.

END OF SECTION 23 05 93

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes the pipe, fittings and components for refrigeration piping systems.

1.2 SUMMARY

- A. This section includes the following materials and methods.

1. Refrigerant piping.
2. Unions, flanges, and couplings.
3. Pipe hangers and supports.
4. Refrigerant moisture and liquid indicators.
5. Valves.
6. Refrigerant strainers.
7. Refrigerant pressure regulators.
8. Refrigerant pressure relief valves.
9. Refrigerant filter-driers.
10. Refrigerant solenoid valves.
11. Refrigerant expansion valves.
12. Electronic expansion valves.
13. Refrigerant receivers.
14. Underground pipe markers.
15. Bedding and cover materials.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. The General Conditions of the Contract, Supplementary Conditions and General Requirements are a part of the Project Specification and shall be used in conjunction with this Division as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Contractors shall be responsible for and be governed by all requirements thereunder.

- B. Related Sections:

- | | |
|--|------------------|
| 1. Common Work Results for HVAC Systems | Section 23 05 00 |
| 2. Valves and Piping Components for HVAC Systems | Section 23 05 23 |
| 3. Testing Adjusting and Balancing | Section 23 05 93 |
| 4. HVAC Ducts and Casings | Section 23 31 00 |

1.4 QUALITY ASSURANCE

- 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.

1.5 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-407C:
1. Suction Lines for Air-Conditioning Applications: 230 psig.
 2. Suction Lines for Heat-Pump Applications: 380 psig.
 3. Hot-Gas and Liquid Lines: 380 psig.
- B. Line Test Pressure for Refrigerant R-410A:
1. Suction Lines for Air-Conditioning Applications: 300 psig.
 2. Suction Lines for Heat-Pump Applications: 535 psig.
 3. Hot-Gas and Liquid Lines: 535 psig.

1.6 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use brass ball valve and 6" long brass nipple when joining dissimilar metals in the systems.

- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.
- C. Provide receivers on systems if recommended by equipment supplier.
- D. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.7 SUBMITTALS

- A. Submit the manufacturer's technical product and performance data for all pipe and fittings.
 - 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.
 - 4. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
 - a. Refrigerant. Type.
 - b. Refrigerant moisture and liquid indicators.
 - c. Refrigerant strainers.
 - d. Refrigerant pressure regulators.
 - e. Refrigerant pressure relief valves.
 - f. Refrigerant filter-driers.
 - g. Refrigerant solenoid valves.
 - h. Refrigerant expansion valves.
 - i. Electronic expansion valves.
- B. Submit shop drawings which detail all piping and components associated with the project. The shop drawings shall be submitted and approved prior to start of any work. In addition to the requirements listed in Section 15050, the shop drawings shall contain the fabrication details for pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and the attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Submit copies of certificates for welding procedures and personnel.
- D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- F. Welding Certificates.
- G. Submit written reports for all tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
 - 4. Indicate results of refrigerant leak test.

1.8 COORDINATION

- A. Coordinate layout and installation of hydronic, steam, and condensate piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pipe Hangers and Supports
 - 1. B-Line.
 - 2. Tolco.
 - 3. PHD.
- B. Refrigerant Moisture and Liquid Indicators
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.
- C. Valves
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.
- D. Refrigerant Check Valves:
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.
- E. Refrigerant Strainers
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.
- F. Refrigerant Pressure Regulators
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.
- G. Refrigerant Pressure Relief Valves
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.
- H. Refrigerant Filter Driers
 - 1. Alco Controls Div, Emerson Electric Co. Mo
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.

- I. Refrigerant Solenoid Valves
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.
- J. Refrigerant Expansion Valves
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.
- K. Electronic Expansion Valves
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.

2.2 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, drawn
- B. Fittings: ASME B16.22 wrought copper ASTM B16.26 Cast Copper.
 - 1. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.3 UNIONS, FLANGES, AND COUPLINGS

- A. 2 inches and Smaller:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.

2.4 PIPE HANGERS AND SUPPORTS

- A. Conform to ASME B31.5.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.
- C. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
- D. Hangers for Hot Pipe Sizes 2 to 4 inches: 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.
- M. Sheet Lead: ASTM B749.

2.5 REFRIGERANT MOISTURE AND LIQUID INDICATORS

- A. Indicators:
 1. Port: Single or Double, UL listed.
 2. Body: Copper or brass, flared or solder ends.
 3. Sight glass: Color-coded paper moisture indicator with removable element cartridge and plastic cap.
 4. Maximum working pressure: 500 psig
 5. Maximum working temperature: 200 degrees F.

2.6 VALVES

- A. Diaphragm Packless Valves:
 1. UL listed, globe or angle pattern, forged brass body and bonnet solder or flared ends.
 2. Phosphor bronze and stainless steel diaphragms, rising stem and hand wheel.
 3. Stainless steel spring, nylon seats, disc with positive back seating.
 4. Maximum working pressure: 500 psig.
 5. Maximum working temperature: 275 degrees F.
- B. Packed Angle Valves:
 1. Forged brass or nickel-plated forged steel, solder or flared ends.
 2. Forged brass seal caps with copper gasket, rising stem and seat, molded stem packing.
 3. Maximum working pressure: 500 psig.
 4. Maximum working temperature: 275 degrees F.
- C. Ball Valves:
 1. Two-piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals, soldered or threaded ends.
 2. Maximum working pressure: 500 psig.
 3. Maximum working temperature: 325 degrees F.
- D. 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.
- E. Refrigerant Check Valves:
 1. Globe Type:
 - a. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, Teflon seat disc.
 - b. Maximum working pressure: 500 psig.
 - c. Maximum working temperature: 300 degrees F.
 2. Straight Through Type:
 - a. Spring, neoprene seat.
 - b. Maximum working pressure: 500 psig.

- c. Maximum working temperature: 250 degrees F.

2.7 REFRIGERANT STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or Monel reinforced with brass.
 - 2. Maximum working pressure: 430 psig.
- B. Straight Line, Non-Cleanable Type:
 - 1. Steel shell, copper plated fittings, stainless steel wire screen.

2.8 REFRIGERANT PRESSURE REGULATORS

- A. Brass body, stainless steel diaphragm, direct acting or pilot operated with remote pressure pilot, adjustable over 0 to 80 psig range, for maximum working pressure of 450 psig.

2.9 REFRIGERANT PRESSURE RELIEF VALVES

- A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 425 psig setting; selected to ASHRAE 15.

2.10 REFRIGERANT FILTER-DRIERS

- A. Replaceable Cartridge Angle Type:
 - 1. Shell: ARI 710, UL listed, brass, steel, removable cap, for maximum working pressure of 500 psig, inches outside diameter size connections.
 - 2. Filter Cartridge: Pleated media with integral end rings, stainless steel support, ARI 730 rating.
 - 3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina, ARI 730 rating.
 - 4. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets, ARI 710 moisture rating.

2.11 REFRIGERANT SOLENOID VALVES

- A. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem designed to allow manual operation in case of coil failure.
- B. Coil Assembly: UL 429 listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box.

2.12 REFRIGERANT EXPANSION VALVES

- A. Manufacturers:
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 3. Sporlan Valve Division / Parker Hannifin Corporation.

- B. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and oversized at part load.

2.13 ELECTRONIC EXPANSION VALVES

- A. Valve:
 - 1. Brass bodies with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
 - 2. Capacity: Nominal as shown on drawings.
- B. Evaporation Control System:
 - 1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, pre-selection allowance for electrical defrost and hot gas bypass.
- C. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.14 REFRIGERANT RECEIVERS

- A. Internal Diameter 6 inch and Smaller: ARI 495, UL listed, steel, brazed; 400 psig maximum pressure rating, with taps for inlet, outlet, and pressure relief valve.
- B. Internal Diameter 6 inch and Larger: ARI 495, welded steel, tested and stamped in accordance with ASME Section VIII; 400 psig with taps for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

PART 3 - EXECUTION

3.1 INSTALLATION - INSERTS

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

3.2 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

- B. Place hangers within 12 inches of each horizontal elbow.
- C. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- D. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- E. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- F. Prime coat exposed steel hangers and supports in accordance with specifications herein. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

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

- S. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- T. Install insulation as required.

3.4 INSTALLATION - REFRIGERANT SPECIALTIES

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

3.5 FIELD QUALITY CONTROL

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

END OF SECTION 23 23 00

SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the fabrication and installation of material and equipment associated with the air distribution system.

1.2 SUMMARY

- A. This section includes the following materials and methods.
 - 1. Ductwork

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. The General Conditions of the Contract, Supplementary Conditions and General Requirements are a part of the Project Specification and shall be used in conjunction with this Division as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Contractors shall be responsible for and be governed by all requirements thereunder.
- B. Related Sections:
 - 1. Common Work Results for HVAC Systems Section 23 05 00
 - 2. Testing Adjusting and Balancing Section 23 05 93
 - 3. HVAC Ducts and Casings Section 23 31 00
 - 4. Air Duct Accessories Section 23 33 00

1.4 QUALITY ASSURANCE

- A. The air distribution system's construction and installation shall meet the requirements of any applicable codes and standards listed below:
 - 1. National Fire Protection Association
 - a. NFPA 45, Fire Protection for Laboratories, 1991
 - b. NFPA 54, National Fuel Gas Code, 1992
 - c. NFPA 90A, Installation of A/C and Vent Systems, 1999
 - d. NFPA 90B, Installation of Warm Air Heating and A/C Systems, 1999
 - e. NFPA 91, Installation of Exhaust Systems for Air Conveying of Materials, 1992
 - f. NFPA 92A, Smoke Control Systems, 1993
 - g. NFPA 92B, Smoke Management Systems in Malls, Atria, Large Areas, 1991
 - h. NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations, 1994
 - i. NFPA 101, Life Safety Code, 1994
 - j. NFPA 204M, Smoke and Heat Venting, 1991
 - k. NFPA 211, Chimneys, Fireplaces, and Venting Systems, 1992
 - 2. SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2nd Edition, 1995
 - 3. Air Diffusion Council (ADC) Test Code 1062 and ASHRAE Test Standard 70-1991 for outlets and inlets.

4. Air Movement and Control Association (AMCA) 500- Test Methods for Louvers, Dampers, and Shutters.

1.5 SUBMITTALS

- A. Submit the manufacturer's technical product and performance data for the following:
 1. Factory-fabricated ductwork
 2. Duct sealant and fire stop materials

1.6 ENVIRONMENTAL AIR DUCT CONSTRUCTION STANDARDS

- A. All ducts shall be constructed and installed in accordance with SMACNA HVAC Duct Construction Standards for the pressure classes specified below.
 1. The proprietary TDC and TDF formed-on duct connector systems may be used provided they are limited to ductwork of ± 2 " w.g. or lower pressure class, Seal Class B, and a maximum dimension of 42" or less. All corners shall have sealant back-up plates.
 2. "Ductmate" or WDCI proprietary connector systems are acceptable provided the type of joint and the maximum joint spacing for various gages and pressure classes conform to the SMACNA Duct Construction Standards Manual."
 3. All longitudinal seams shall be Pittsburgh Lock or better. "Snaplock" is not acceptable.
 4. The Contractor will be required to replace all ductwork not in conformance with this specification.
- B. Leakage criteria shall be as follows:
 1. Constant Volume Systems:
 - a. Supply ductwork at 0-2" w.g.
 - 1) Allowable Leakage: 2% of design cfm
 - b. Supply ductwork at 3" w.g. or higher
 - 1) Allowable Leakage: 1% of design cfm
 - c. Return ductwork:
 - 1) Allowable Leakage: 2% of design cfm
- C. Duct sealing shall be per construction and installation standards published in the SMACNA HVAC Duct Construction Standards as follows:

DUCT SEALING REQUIREMENTS

<u>Seal Class</u>	<u>Sealing Required</u>
A	All transverse joints, longitudinal seams, and duct wall penetrations, up to 10" w.g. pressure class

1.7 SOUND CRITERIA

- A. All equipment and material furnished under this section shall be selected so that required NC sound levels in various spaces are not exceeded. Attenuation by ceilings, duct liner, and room absorption may be taken into account when making fan, terminal unit, and air distribution selections. Refer to the latest edition of the ASHRAE Applications Handbook for further information.
- B. Provide sufficient submittal data for terminal units, sound traps, duct liner, and air distribution devices to verify required space sound levels will not be exceeded.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Factory Fabricated Ductwork:
 - 1. Graco
 - 2. Hercules
 - 3. Metco
 - 4. Norlock
 - 5. Semco
 - 6. SPOT
 - 7. McGill Airflow

- B. Duct Liner:
 - 1. CertainTeed (ToughGard)
 - 2. Knauf type E-M
 - 3. Owens-Corning (Aeroflex)
 - 4. Schuller (Permacote Linacoustic).

- C. Duct Sealant:
 - 1. Chicago Mastic Corp.
 - 2. Foster
 - 3. Hardcast
 - 4. SOLVseal
 - 5. Tough Bond
 - 6. McGill Airflow

2.2 SHEET METAL DUCTWORK

- A. All sheet metal used for duct and plenum construction shall be G-90 coated galvanized steel of lock forming quality, conforming to ASTM A653 and ASTM A924.

- B. At installer's option, shop fabricated duct and fittings may be provided in lieu of factory-fabricated duct and fittings. All factory and field fabricated ductwork shall meet the construction criteria established below.

- C. Factory-fabricated, Low-pressure Round Ductwork (-1" to +2" w.g., Seal Class A):
 - 1. Round ductwork shall be spiral seam (Type RL-1) for sizes 3" through 12", spiral seam (Type RL-1) for 14" through 78", and rolled longitudinal butt welded seam (Type RL-4) construction for sizes 79" and larger.
 - 2. Elbows shall have a centerline radius of 1.5 times the duct diameter.
 - a. 10" and smaller shall be one-piece construction for 90-degree and 45-degree elbows.
 - b. Over 10" shall be segmented with welded circumferential joint or standing seam construction.
 - 3. Transverse joints shall be a beaded interior sleeve joint.
 - 4. All round ductwork and fittings shall be constructed to be suitable for use on systems with positive static pressures up to 2" w.g.

2.3 DUCT LINER

1. Provide liner as indicated in table below or as listed in the Project Drawings. All duct sizes shown on drawings are clear internal dimensions and do not include liner.

System	Thickness	Material
Exposed Rectangular Supply	1"	Flat board
Exposed Round Supply	1"	Round board
Concealed Rectangular Supply	1"	Flat board
Concealed Round Supply	1"	Round board
Exposed Rectangular Return	----	Flat board
Exposed Round Return	----	Round board
Concealed Rectangular Return	1"	Flat board
Concealed Round Return	----	Round board

B. Material:

1. All liner material shall comply with the requirements of NFPA 90A and 90B, UL 181 Class 1, ASTM C1071, and the Materials Standard of the North American Insulation Manufacturer's Association (NAIMA); Type 200, Flame Spread 25 max. and Smoke Development 50 max.
2. All liner material shall not absorb more than 1% moisture when tested per ASTM C1104.
3. All liner material shall not cause corrosion of duct material (aluminum or galvanized steel) when tested per ASTM C665.
4. All liner material shall not breed or promote growth of fungi and/or bacteria when tested per ASTM C1071, G-21, and G-22. Coating shall include an EPA-registered anti- microbial agent.
5. Airstream surface and transverse edge shall be factory coated with a tough composite material to provide a maximum average velocity rating of 5,000 fpm or better at 250°F when tested per ASTM C1071.
6. Flat liner board shall have a nominal "k" value of 0.23 or less for 1" thick liner when tested per ASTM C518 at 75°F mean temperature. Round liner board shall have a nominal "k value of 0.23 or less for 1" thick liner when tested per ASTM C518-85 at 75°F mean temperature.
7. Flat liner board shall have a sound absorption coefficient of 0.91 or higher at 1,000 Hz for 1" thick liner when tested per ASTM C423-90 Type A mounting. Round liner board shall have a sound absorption coefficient of 1.01 or higher at 1,000 Hz for 1" thick liner when tested per ASTM C423-90 Type A mounting.
8. All liner shall be installed in accordance with manufacturer's written installation instructions, including cut edge treatment, welded pins, pin spacing and adhesive installation. All liner shall be installed in accordance with SMACNA installation requirements.

2.4 DUCT SEALANT

- A. All duct sealant shall comply with requirements of NFPA 90A and 90B, Flame Spread 25 max. and Smoke Developed 50 max. Sealant shall be UL classified as fire resistive when dry.
- B. Duct joint and Seam Sealant Options:
 1. Tape System: Woven fiber, 3" tape impregnated with a gypsum mineral compound using an Acrylic Copolymer adhesive to form a hard, durable seal.
 2. Liquid Sealant: Polymeric rubber sealant formulated with a minimum of 70% solids and manufactured specifically for sealing joints and seams in low, medium, and high pressure ductwork.
- C. Sealant used on outdoor ductwork shall be listed and approved for outdoor service.

PART 3 - EXECUTION

3.1 DUCT CONSTRUCTION AND INSTALLATION

- A. All ductwork shall be fabricated and installed so that no undue vibration or noise results. Joints shall be sealed airtight using criteria established for each seal class and additional sealant and caulking shall be provided if necessary.
- B. Hang rectangular ducts with strap iron attached to bottom of ducts and spaced not over 5' center to center.
- C. Square elbows shall have single-thickness turning vanes.
- D. Provide all necessary manual, backdraft, and relief dampers as required for proper adjustment and control of air distribution.
 - 1. Provide a 45-degree entry fitting at all branches in rectangular ductwork, except where parallel flow branches are used.
 - 2. Manual dampers shall have rigid bearings and locking quadrants which allow no rattling. Damper rods shall be marked to indicate the relative position of the damper blade with respect to the rod.
 - 3. Backdraft and relief dampers shall be installed per the manufacturer's recommendations.
 - 4. Provide volume extractors similar to Titus AG45 set at 20° in ductwork behind sidewall supply registers.
- E. Provide 1" angle collars for all exposed ducts passing through walls, ceilings, or floors. Anchor collars in position after installation is complete.
- F. Provide flexible connections at inlet and discharge duct connections to in-line fans, fan coil units, and air handling equipment. Flexible connections shall be securely fastened to the duct and equipment per SMACNA Duct Construction Standards. Provide at least 1" of slack.
- G. At all locations where interior of duct is visible through grilles, louvers, etc., paint interior of duct flat black.
- H. Install sash lock type access panels or removable pin hinged access doors on ductwork to provide access to all parts of every automatic damper, fire and/or smoke damper, upstream and downstream of duct coils, and any other item requiring maintenance or inspection. Panels and/or doors shall be gasketed to minimize leakage. Fire damper access doors shall be painted red.
- I. Transitions in ductwork shape and size shall be made with angles not exceeding 15 degrees diverging or 30 degrees converging.
- J. Where vertical ducts pass through floors, supporting angles shall be rigidly attached to ducts and to the floor. Angles shall be galvanized and of approved sizes to properly support the ductwork. The supporting angles shall be placed on at least two sides of the duct.
- K. Where horizontal ducts pass through walls and vertical ducts pass through floors, opening shall be filled to provide a tight seal between duct and opening. Refer to Part 2 of this section for approved fire stop materials to be used at all rated walls and floors.
- L. Contractor shall not provide holes in any duct for the installation of hangers, conduits, other equipment, etc. The work of all other trades shall be coordinated before work begins.

- M. Clean ductwork internally of dust and debris as it is installed. Clean external surfaces of foreign substances which might cause corrosion or deterioration. Where ductwork is to be painted clean all substances which might interfere with painting or cause paint deterioration.
- N. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.
- O. A temporary cover shall be provided for ducts which when installed have not been connected to equipment, other ductwork, or air distribution devices. Temporary cover shall be plywood, corrugated cardboard backed polyethylene film, or other covering which will prevent entrance of dust and debris until connections are completed.
- P. Flexible ducts shall be installed using lengths at least 4' long, but not exceeding 8' for all connections. Flexible duct shall be suspended at intervals not exceeding 3 ft. with a 1"-wide, 22-gauge steel band. Maximum allowable sag is 1/2" per foot of spacing between supports. All connections shall be made with stainless steel duct clamp with worm gear fastener.
- Q. All moisture-laden air exhaust ducts shall be constructed with longitudinal seams on the top side of the duct and shall be pitched to drain toward a grille.

3.2 SEALING OF DUCTS

- A. All ducts shall be sealed as defined in Part 1 of this section. Apply duct sealant per the manufacturer's written instructions, but at a minimum perform the following. Metal surfaces shall be clean, dry, and grease-free prior to applying sealant. Apply a heavy brushed on coat of sealant to the surface of the duct slip joint, position ducts and secure sections in place. Apply a finish heavy brushed on coat of sealant to the exterior surface covering the joint and heads of lock joint screws. Ensure that all voids are completely filled to ensure a continuous air pressure seal.
- B. Where excessive duct vibration or mechanical abuse is possible, and additional joint finish shall be applied. Apply a heavy brushed on coat of sealant to the exterior surface joint and lay a reinforcing membrane of glass fabric approximately 2" wide onto the wet sealant. Press the reinforcing membrane into the wet sealant. Apply a second heavy brushed on coat of sealant.

END OF SECTION 23 31 00

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the fabrication and installation of material and equipment associated with the air distribution system.

1.2 SUMMARY

- A. This section includes the following materials and methods.
 - 1. Duct dampers and accessories
 - 2. Grilles, registers, and diffusers
 - 3. Air filters and gauges

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. The General Conditions of the Contract, Supplementary Conditions and General Requirements are a part of the Project Specification and shall be used in conjunction with this Division as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Contractors shall be responsible for and be governed by all requirements thereunder.
- B. Related Sections:
 - 1. Common Work Results for HVAC Systems Section 23 05 00
 - 2. Testing Adjusting and Balancing Section 23 05 93
 - 3. HVAC Ducts and Casings Section 23 31 00
 - 4. Air Duct Accessories Section 23 33 00
 - 5. HVAC Fans Section 23 34 00

1.4 QUALITY ASSURANCE

- A. The air distribution system's construction and installation shall meet the requirements of any applicable codes and standards listed below:
 - 1. National Fire Protection Association
 - a. NFPA 45, Fire Protection for Laboratories, 1991
 - b. NFPA 54, National Fuel Gas Code, 1992
 - c. NFPA 90A, Installation of A/C and Vent Systems, 1999
 - d. NFPA 90B, Installation of Warm Air Heating and A/C Systems, 1999
 - e. NFPA 91, Installation of Exhaust Systems for Air Conveying of Materials, 1992
 - f. NFPA 92A, Smoke Control Systems, 1993
 - g. NFPA 92B, Smoke Management Systems in Malls, Atria, Large Areas, 1991
 - h. NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations, 1994
 - i. NFPA 101, Life Safety Code, 1994
 - j. NFPA 204M, Smoke and Heat Venting, 1991
 - k. NFPA 211, Chimneys, Fireplaces, and Venting Systems, 1992

2. SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2nd Edition, 1995
3. Air Diffusion Council (ADC) Test Code 1062 and ASHRAE Test Standard 70-1991 for outlets and inlets.
4. Air Movement and Control Association (AMCA) 500- Test Methods for Louvers, Dampers, and Shutters.

1.5 SUBMITTALS

- A. Submit the manufacturer's technical product and performance data for the following:
 1. Duct access doors
 2. Flexible connectors
 3. Manual volume dampers
 4. Grilles, registers, and diffusers

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit the manufacturer's operation and maintenance data for the following:
 1. Duct access doors
 2. Control dampers
 3. Grilles, registers, and diffusers

1.7 SOUND CRITERIA

- A. All equipment and material furnished under this section shall be selected so that required NC sound levels in various spaces are not exceeded. Attenuation by ceilings, duct liner, and room absorption may be taken into account when making fan, terminal unit, and air distribution selections. Refer to the latest edition of the ASHRAE Applications Handbook for further information.
- B. Provide sufficient submittal data for terminal units, sound traps, duct liner, and air distribution devices to verify required space sound levels will not be exceeded.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Duct Access Doors:
 1. Air Balance
 2. Nailor
 3. Ruskin
- B. Flexible Connectors:
 1. Ventfabrics
 2. Duro-Dyne

- C. Manual Volume Dampers:
 1. Ruskin
 2. Pottoroff
 3. Greenheck
 4. Louvers & Dampers
 5. Nailor

- D. Control Dampers:
 1. Ruskin
 2. Pottoroff
 3. Greenheck
 4. Louvers & Dampers
 5. Nailor

- E. Grilles, Registers, and Diffusers:
 1. Titus
 2. Anemostat
 3. Carnes
 4. Krueger
 5. Metal Aire
 6. Nailor

2.2 DUCT ACCESS DOORS

- A. All access doors shall be fabricated to meet SMACNA HVAC Duct Construction Standards unless more stringent criteria are listed below.

- B. Rectangular Duct Access Doors:
 1. Provide with double wall construction, galvanized steel inner and outer panels, die formed galvanized steel frame, 1" fiberglass insulation between double wall panels, and polyethylene gasket securely attached to access door
 2. Provide a single removable piano type hinge with steel camlock fasteners. Hinge shall extend full length of access panel. Screw fasteners are not acceptable.

- C. Round Duct Access Doors:
 1. Access door construction and materials shall be the same as rectangular duct access doors. Provide a built-out flat section to accommodate access door.

- D. Access panel sizes and gauges shall be as follows unless otherwise specified on drawings:

Duct Size	Panel Size	Number of Latches	Material Gauges		
			Frame	Exterior Panel	Interior Panel
6" to 8"	4"x8"	1	22	22	26
10" to 12"	8"x12"	1	22	22	26
12" to 16"	10"x16"	3	20	20	26
Over 18"	16"x24"	4	20	20	24

2.3 TURNING VANES

- A. Provide single vane type, constructed from 22 gauge (min.) galvanized sheet metal.
- B. Turning vanes shall be securely fastened to runners to maintain equidistant between all points on adjacent blades and provided with trailing edges to project air parallel to duct sides.
- C. Provide turning vanes constructed per SMACNA HVAC Duct Construction Standards.

2.4 FLEXIBLE CONNECTIONS

- A. Provide a flexible duct connection wherever ductwork connects to vibration isolated equipment.
- B. Flexible connector shall be constructed of a 3" wide strip of flexible material between two 3" wide 24 gauge galvanized steel strips.
- C. For interior applications the flexible material shall be constructed of a base woven fiberglass fabric with a neoprene coating. Flexible material shall have a tensile strength of 500 lbs, a tear strength of 13 lbs, and a weight of 30 ounces per square yard. Basis of design is Duro-Dyne Metal Fab with Neoprene fabric.
- D. For exterior applications the flexible material shall be constructed of a base woven fiberglass fabric with a hypalon coating. Flexible material shall have a tensile strength of 250 lbs, a tear strength of 13 lbs, and a weight of 24 ounces per square yard. Basis of design is Duro-Dyne Metal Fab with Durofon fabric

2.5 MANUAL VOLUME DAMPERS

- A. Rectangular manual volume dampers for low velocities (1,500 fpm or less)
 - 1. Provide 16 gauge galvanized steel channel frame.
 - 2. Provide 16 gauge galvanized steel opposed or parallel blades with 1/2" hex axle. Maximum blade width of 8", except single blade may be up to 12". Blades 36" and longer shall be furnished with reinforcing cone. Maximum blade length of 48".
 - 3. Provide 3/8" control shaft with locking quadrant.
 - 4. Basis of design is Ruskin MD 35.
- B. Round manual volume dampers for low velocities (1,500 fpm or less)
 - 1. Provide single blade to 20" diameter and multi-blades above 20" diameter.
 - 2. Provide 20-gauge blade and frame to 12" diameter and 18-gauge blade above 12" diameter.
 - 3. Basis of design is Ruskin MDRS 25.
- C. Rectangular manual volume dampers for medium velocities (1,500 to 4,000 fpm)
 - 1. Provide 16 gauge galvanized steel channel frame reinforced with corner braces.
 - 2. Provide airfoil opposed blade double skin galvanized steel construction with 16 gauge equivalent thickness and flexible blade seals mechanically locked to blade edge.
 - 3. Provide permanently lubricated stainless steel sleeve bearings mounted in frame.
 - 4. 1/2"-diameter control shaft with locking quadrant.
 - 5. Basis of design is Ruskin CD60.

2.6 CONTROL DAMPERS

- A. All control dampers shall be low leak parallel or opposed blade configuration with published leakage data certified under the AMCA certified ratings program.
 - 1. Leakage shall be less than 5.0 cfm per sq. ft. of area at 4-in. w.g. pressure difference through a 48" x 48" damper.
 - 2. The published leakage data shall include leakage rates for all available damper sizes at pressure differences from 1 in w.g. through 13 in w.g.
 - 3. Blade configuration shall be as indicated in the control diagrams in the Project Drawings.
- B. Materials:
 - 1. Low leak dampers shall be constructed of 5" x 1" x 0.125" 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame.
 - 2. Blades shall be airfoil type extruded 6063T5 aluminum with an integral structural reinforcing tube running the full length of each blade. Maximum blade depth shall be 6".
 - 3. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket that enables air pressure from either direction to assist in blade to blade seal.
 - 4. Blades shall be mechanically locked in extruded blade slots. Adhesive or clip-on type blade seals are not acceptable.
 - 5. Bearings shall be non-corrosive molded synthetic. Axles shall be square or hexagonal to provide positive locking connection to blades and linkage.
 - 6. Linkage shall be concealed in the frame.
- C. Actuators:
 - 1. Damper actuators, electric or pneumatic, shall be as indicated on the Project Drawings.
 - 2. Damper actuators shall be Listed under UL 873.
 - 3. Damper actuator shall have a visual and electronic position indicator.
 - 4. Damper actuator housing shall be die cast aluminum.
 - 5. Damper actuator shall be provided with a spring return with minimum close time of 15 seconds and maximum close time of 30 seconds. Spring return shall be configured as follows:
 - a. Outside air damper shall fail normally closed.
 - b. Return air damper shall fail normally open.
- D. Control damper basis of design is Ruskin CD50. Control actuator basis of design is Seimens GCA series.

2.7 GRILLES, REGISTERS, AND DIFFUSERS

- A. All grilles, registers, and diffusers shall be performance tested and rated in accordance with ASHRAE Standard 70-1991 and ANSI S1.31-1980.
- B. Provide grilles, registers, and diffusers of face size, neck size, and style indicated and scheduled on the Project Drawings. Provide all scheduled accessories and options from the grille, register, and diffuser manufacturer.
- C. Provide all grilles, registers, and diffusers with white baked-on enamel finish, unless noted otherwise.
- D. Provide all grilles, registers, and diffusers with a border style compatible with the required mounting surface. Provide grilles, registers, and diffusers that are specifically manufactured for each type of mounting surface to provide an accurate fit and adequate support. Refer to the Project Drawings and Specifications for mounting surfaces and ceiling systems.
- E. Sidewall Supply Grilles:

1. Provide grilles constructed of 20 gauge aluminum.
2. Provide adjustable double deflection airfoil blades with ¾" spacing. Exterior blades shall be horizontal.
3. DO NOT provide a volume dampers at neck unless specifically indicated or scheduled.
4. Basis of design is Titus 272FL.

F. Sidewall Return and Transfer Grilles:

1. Provide fixed 35 degree deflection grilles with ¾" blades spacing. Blades shall be horizontal.
2. Provide construction material as indicated on the Project Drawings.
3. DO NOT provide a volume dampers at neck unless specifically indicated or scheduled.
4. Basis of design is Titus 350 Series.

G. Exhaust Registers:

1. Provide fixed 35 degree deflection grilles with ¾" blades spacing. Blades shall be horizontal.
2. All registers components shall be constructed of aluminum.
3. DO NOT provide a volume dampers at neck unless specifically indicated or scheduled.
4. Basis of design is Titus 350FL.

PART 3 - EXECUTION

3.1 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4" larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within $\pm 1/8"$.
- D. Follow manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft per manufacturer's instructions. Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.
 1. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to assure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- F. Provide a visible and accessible indication of damper position on the drive shaft end.
- G. Support duct on both sides of damper to prevent sagging due to damper weight.
- H. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.2 GRILLES, REGISTERS, AND DIFFUSERS

- A. Grilles, registers, and diffusers shall be installed and supported per manufacturer's recommendations and per the UBC.
 - 1. Ceiling-mounted air devices or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
 - 2. Devices or services weighing 20 pounds, but not more than 56 pounds, in addition to the above, shall have two No. 12-gauge hangers connected from the device or service to the ceiling system hangers or to the structure above. These wires may be slack.
 - 3. Air devices or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.
 - 4. Seal the neck joints on all grilles, registers and diffusers.
- B. Throw patterns (directions) shall be furnished and/or adjusted to match those shown and/or scheduled on the drawings.
- C. Ductwork visible behind grilles, registers, and diffusers shall be painted flat black.
- D. Appropriate A_k factors shall be transmitted to the Test and Balance Contractor.

END OF SECTION 23 33 00

SECTION 23 34 00

HVAC FANS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes air moving devices and associated components.

1.2 SUMMARY

- A. This section includes the following materials and methods.
1. Ceiling-mounting ventilators

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. The General Conditions of the Contract, Supplementary Conditions and General Requirements are a part of the Project Specification and shall be used in conjunction with this Division as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Contractors shall be responsible for and be governed by all requirements thereunder.

B. Related Sections:

- | | |
|---|------------------|
| 1. Common Work Results for HVAC Systems | Section 23 05 00 |
| 2. Testing Adjusting and Balancing | Section 23 05 93 |
| 3. HVAC Insulation | Section 23 07 00 |
| 4. HVAC Ducts and Casings | Section 23 31 00 |
| 5. Air Duct Accessories | Section 23 33 00 |
| 6. HVAC Fans | Section 23 34 00 |

1.4 QUALITY ASSURANCE

- A. Electrical components, devices, and accessories shall be 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. Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. Motors and electrical accessories shall comply with NEMA standards.
- D. Power ventilators shall comply with UL 705.

1.5 SUBMITTALS

- A. Submit product and performance data for all fans used on the project and include the following:
1. Certified fan performance curves with system operating conditions indicated.
 2. Certified fan sound-power ratings.
 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.

4. Material gauges and finishes.
5. Dampers, including housings, linkages, and operators.
6. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
7. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit the manufacturer's operation and maintenance data for all fans used in this project.

1.7 PERFORMANCE REQUIREMENTS

- A. All fan ratings and performance shall be based upon the project elevation.

1.8 EXTRA MATERIALS

- A. Provide two extra sets of belts for each belt driven fan. The extra belt[s] shall match the installed material and shall be packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ceiling-Mounting Ventilators:
 1. Greenheck Fan Corp.
 2. Penn Ventilation Companies, Inc.
 3. Twin City

2.2 GENERAL REQUIREMENTS

- A. All fans shall comply with AMCA Standard 301, "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Fans shall be tested in accordance with AMCA Standard 300, "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
- B. Fan flow rate, pressure, power, air density, speed of rotation, and efficiency shall be established by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51, "Laboratory Methods of Testing Fans for Rating."
- C. Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.
- D. All fans and shafts shall be statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower. The fan shaft shall be turned, ground, and polished steel, designed to operate at no more than 70% of the first critical speed at the top of the speed range of the fan's class.

- E. Belt drives shall be rated for 150% or more of motor horsepower, factory-mounted and adjustable, with final alignment and belt adjustment made after installation.
- F. Belts shall be oil-resistant, non-sparking, and non-static.
- G. Fan wheel pulleys shall be adjustable pitch for use with motors through 15 hp and shall be fixed pitch for use with motors larger than 15 hp. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions. Provide an OSHA approved steel belt guard with tachometer openings for the motor and fan shaft for all exposed belts.
- H. Provide all shaft bearings with a median life "Rating Life" (AFBMA L₅₀) of 200,000 hours, calculated in accordance with Anti-Friction Bearing Manufacturer's Association (AFBMA) Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.
- I. All three-phase fan motors 1 hp through 200 hp shall be energy-efficient type meeting EPACT 92 requirements. Reference Section 15050 for additional motor requirements. Fan motors shall be selected so that they do not operate in the service factor at total pressures $\pm 20\%$ from selection point.
- J. Provide the following factory finishes:
 1. Sheet Metal Parts: Prime coating prior to final assembly.
 2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.3 CEILING-MOUNTING VENTILATORS

- A. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
 1. Isolation: Rubber-in-shear vibration isolators.
 2. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1 inch.
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Install units with clearances for service and maintenance.
- E. Label units according to requirements specified in Division 23.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Equipment Startup Checks:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Verify lubrication for bearings and other moving parts.
 - 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 7. Disable automatic temperature-control operators.
- B. Starting Procedures:
 - 1. Energize motor and adjust fan to indicated rpm.
 - 2. Measure and record motor voltage and amperage.
- C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Shut unit down and reconnect automatic temperature-control operators.
- F. Replace fan and motor pulleys as required to achieve design airflow.
- G. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.

3.5 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Review data in maintenance manuals.
 - 3. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 23 34 00

SECTION 23 63 33

EVAPORATIVE REFRIGERANT CONDENSING UNIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Indoor mounted evaporative cooled refrigerant condensing unit. The unit shall be a forced draft, centrifugal fan, counterflow Evaporative Condenser. The unit shall be of low profile design with a single fan mounted on the end of the unit for convenient access by service personnel. The unit ships completely factory assembled with optional accessories factory installed unless specified otherwise.
- B. Related Sections:
 - 1. Common Work Results for HVAC Systems Section 23 05 00
 - 2. Testing Adjusting and Balancing Section 23 05 93

1.3 SUBMITTALS

- A. Provide product data including manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.
- B. Provide shop drawings which detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Provide maintenance data for equipment to include in the maintenance manuals specified in Division 1.
- D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Unit shall be rated in accordance with AHRI Standard 340/360.
- B. Unit construction shall comply with ANSI/ASHRAE 15 safety code latest revision and comply with NEC.
- C. Unit shall be constructed in accordance with UL 1995 standard and shall carry the UL and UL, Canada label.

- D. Unit cabinet shall be capable of withstanding 500-hour salt spray exposure per ASTM B117 (scribed specimen).
- E. Air-cooled condenser coils for hermetic scroll compressor units 38AUZ and 38AUD shall be leak tested at 150 psig, and pressure tested at 650 psig.
- F. Unit shall be manufactured in a facility registered to ISO 9001:2008 manufacturing quality standard.

1.5 COORDINATION

- A. Coordinate installation of unit with existing penthouse air handler panel system, including removing existing roof panels for existing unit removal and new unit installation. Any existing panels removed shall be reinstalled to provide a weathertight envelope and painted to match surrounding panels.

1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.
 - 1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Substantial Completion.
 - 2. Warranty Period, Heat Exchangers: Manufacturers standard, but not less than 10 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Air Cooled Condensing Units
 - 1. Marley SPX
 - 2. Or pre Approved Equal

2.2 AIR COOLED CONDENSING UNIT

- A. General:
 - 1. Factory-assembled, single piece, air-cooled condensing unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, holding charge, and special features required prior to field start-up.
- B. Unit Cabinet:
 - 1. The casing panels shall be constructed of heavy gauge G-235 galvanized steel. The casing panels shall be flanged outward so that all the connecting fasteners are located outside the flooded section of the unit. No welded joints below the water line. The unit is designed for a 30 psf on any

projected area and ships in one piece on a minimum 6" high galvanized steel channel base to help in handling and installation of the unit.

C. Unit Sump Basin:

1. The sump pan shall be constructed of heavy gauge, series 301L (low carbon) stainless steel.
2. The unit shall be provided with all sump pan sides, floor panels, coil supports, anti-cavitation swirl arrestor hood, external float box, upper casing panels, drift eliminator and spray system supports and drift eliminator access panel constructed of heavy gauge series 300 stainless steel. The sump pan and casing panels shall be flanged outward so that all the connecting fasteners are located outside the flooded section of the unit . No welded joints below the water line.

D. Condenser Fans:

1. The unit design shall have the fan wheel and motor and drive components in the dry, entering airstream. The fan wheel shall be statically and dynamically balanced and mounted on a solid steel fan shaft supported on each end with self-aligning heavy-duty pillow block bearings. The bearings are rated for 200,000-hour life.
2. Provide extended grease lines for easy maintenance.
3. The v-belt drive system shall be designed for 150% of motor horsepower and the fan housing shall be equipped with curved inlet rings for maximum efficiency.
4. The fan motor shall be energy efficient type as standard and meets new governmental **EPACT** efficiency standards, TEFC motor suitable for outdoor usage.

E. Condenser Coils:

1. The coil shall be constructed entirely of copper to provide superior corrosion resistance.
2. The tubes shall be 5/8" O.D. copper tubing and type L headers.
3. The coil shall be supported by stainless steel tube sheets and high temperature grommet inserts that allow the coil to move within the insert. The coil is then pressurized to 350 P.S.I. and submerged under water for 30 minutes to assure a leak-free coil.

F. Accessibility:

1. The unit shall have as standard 19"x27" stainless steel access doors that provide a watertight seal without the use of gaskets or fasteners. A minimum of 2 doors shall be provided.

G. Water Distribution Systems:

1. The unit spray distribution system shall be designed to evenly distribute the spray water over the coil, continuously wetting the coil. The spray nozzles shall be made of PVC and are of a large-orifice design to help prevent clogging. The spray nozzle shall distribute the water in a full 360-degree radius for maximum distribution.
2. The internal piping shall be minimum schedule 40 PVC and piping shall extend through the unit casing to allow flushing of the system when needed. The spray nozzles shall be attached to the piping with stainless steel clamps, can be inspected or removed through one of the stainless steel access doors. The re-circulating unit pump shall be a close-coupled, centrifugal type pump that uses a mechanical seal. A stainless steel anti-vortexing hood shall be provided on pump suction. The pump is specifically sized for the spray system and is located on the unit skid for easy access.

H. Make-Up Water System:

1. The unit shall use a solid brass make-up water valve with a large diameter plastic float that is located on the exterior of the sump pan. The make-up valve shall be positioned above the overflow connection so that backflow preventors are not required.

I. Drift Eliminators:

1. The drift eliminators shall be made from heavy duty schedule 40 PVC for and shall be installed sectionally to allow easy handling by maintenance personnel. The eliminator design shall have 3 changes in airflow direction and a drift rating of 002% of the spray water re-circulation rate.

- J. Sump Pan Heater Package:
 - 1. Provide a sump pan heater to provide 40 deg. F. sump pan water temperature at a -10 deg. F. dry bulb temperature. The package shall include immersion heater, low water cutout switch and submersible bulb thermostat. Components shall be wired to factory installed control-starter panel.
- K. Positive Closure Damper Assembly:
 - 1. Provide a low profile, maximum 6-1/2" damper assembly installed on discharge outlet area of the unit. Package shall include damper blade assembly, linkage and damper actuators. Damper shall be designed to prevent convection through the unit when unit not in use.
- L. Control-Starter Panel:
 - 1. Provide a factory mounted and wired Control-Starter Panel in a NEMA 3R enclosure, with U.L. label to include fan and pump starters, heater and positive closure damper wiring, disconnect switch, 2 stage aqua-stat installed in leaving water loop. Panel to receive operational test at factory, then shipped loose for mounting on unit at jobsite.
- M. Operating Characteristics:
 - 1. The capacity of the condensing unit shall meet or exceed the capacity and performance requirements listed in the Project Drawings.
 - 2. Standard unit shall be capable to operate up to 125F and down to 40F
- N. Electrical Requirements:
 - 1. Electrical characteristics shall be as indicated in the Project Drawings.
 - 2. Unit electrical power shall be single-point connection.
 - 3. Unit control circuit shall contain a 24-v transformer for unit control.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install unit level and plumb.
- B. Install ground-mounted, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Coordinate anchor installation with concrete base.

3.2 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 - 1. Start up, test and commission the unit to verify operation and conformance to the specified sequence of operation. Start up, testing and commissioning shall be by a factory authorized service representative and shall be witnessed by the Owner's maintenance personnel. Provide testing, start up and commissioning documents in operation and maintenance manual.
 - 2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 3. Schedule testing, commissioning and training with Owner with at least 7 days' advance notice.

END OF SECTION 23 63 33

SECTION 23 82 00 - AIR COILS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes air coils not specified with an air handler or terminal unit.

1.2 SUMMARY

- A. This section includes the following materials and methods.
 - 1. Refrigerant Coils

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. The General Conditions of the Contract, Supplementary Conditions and General Requirements are a part of the Project Specification and shall be used in conjunction with this Division as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Contractors shall be responsible for and be governed by all requirements thereunder.
- B. Related Sections:
- C. Related Sections:
 - 1. Common Work Results for HVAC Systems Section 23 05 00
 - 2. Valves and Piping Components for HVAC Systems Section 23 05 23
 - 3. Testing Adjusting and Balancing Section 23 05 93
 - 4. HVAC Ducts and Casings Section 23 31 00

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 ARI 410, "Standard for Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.
 - 1. Certify coils to ARI 410, "Standard for Forced-Circulation Air-Cooling and Air-Heating Coils."

1.5 SUBMITTALS

- A. Provide rated capacities of selected models; pressure drop; shipping, installed, and operating weights; installation instructions; and startup instructions for each product used on this project.
- B. Provide shop drawings which detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Provide wiring diagrams for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Refrigerant Coils:
 - 1. REA
 - 2. Or Pre Approved Equal

2.2 REFRIGERANT COILS

- A. Description: Continuous circuit coil fabricated to ARI 410.
 - 1. Piping Connections: Threaded, on same end.
- B. Tubes: Copper, complying with ASTM B 75.
 - 1. Tube Diameter: 0.625 inch.
 - 2. Minimum Tube Thickness: 0.020 inch.
- C. Fins: Aluminum with fin spacing of 10 fins per inch.
 - 1. Fin and Tube Joint: Mechanical bond.
- D. Headers: Seamless copper tube with brazed joints.
- E. Frames: Galvanized-steel channel frame.
- F. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
 - 1. Working Pressure Ratings: 200 psig, 325 deg F.
 - 2. Source Quality Control: Test to 300 psig, and to 200 psig underwater.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and units to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Unless otherwise indicated, connect piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Refer to piping system Sections for specific valve and specialty arrangements.

3.4 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Straighten bent fins on each air coil.

3.5 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

END OF SECTION 23 82 00

SECTION 25 30 00

AUTOMATION INSTRUMENTATION AND TERMINAL DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the features and installation of devices associated with the modifications to the existing Setpoint temperature control system. This section also describes the installation, testing, demonstration, and commissioning of the temperature control system.

1.2 SUMMARY

- A. This section includes the following materials and methods.
 1. Pre-assembled control panels.
 2. Actuators, thermostats, sensors, transmitters, thermowells, instrument air compressors, filter/dryers, gauges, and mounting hardware as applicable.
 3. Control valves, dampers, linkages, and mounting hardware.
 4. Construction supervision.
 5. Startup and commissioning.
 6. Demonstration and training.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. The General Conditions of the Contract, Supplementary Conditions and General Requirements are a part of the Project Specification and shall be used in conjunction with this Division as a part of the Contract Documents. Consult them for further instructions pertaining to this work. Contractors shall be responsible for and be governed by all requirements thereunder.
- B. Related Sections:
 1. Common Work Results for HVAC Systems Section 23 05 00
 2. Testing Adjusting and Balancing Section 23 05 93
 3. HVAC Ducts and Casings Section 23 31 00
 4. Air Duct Accessories Section 23 33 00
 5. HVAC Fans Section 23 34 00

1.4 QUALITY ASSURANCE

- A. Refer to Section 23 05 00 for general code, standard, and regulatory requirements.
- B. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's Representative in writing. This requirement is not intended to restrict the Control Contractor to the use of outdated equipment.
- C. All products used in this installation shall be new and currently under manufacture. Spare parts shall be available for at least five years after completion of this contract.

1.5 SUBMITTALS

- A. Submittal data and control drawings for all equipment and systems shall be submitted to the Owner's Representative for review prior to ordering or fabrication of any equipment. The following information shall be included in these submittals:
1. 30 Days or Less After Notice to Proceed:
 - a. Control valve and damper schedules.
 - b. The valve and damper schedules shall also be submitted to the Mechanical Contractor for review by the piping and sheet metal contractors.
 - c. Product data for all products used in conjunction with the control system.
 - d. Torque charts showing the butterfly valve actuators are oversized as required elsewhere in this specification.
 2. 60 Days or Less After Notice to Proceed:
 - a. Control drawings
 - b. Software information
 - c. Test Plan and procedures
 3. 60 Days or More Prior to Scheduled Startup of the First Controlled System:
 - a. Software programming data
 - b. Test plan and procedures
 4. 10 Days or More Prior to Scheduled System Demonstration:
 - a. Pressure test report for pneumatic tubing.
 - b. Operational logs as described in Part 3
 - c. Test plan with hardware and software testing results, calibration reports and technician certification
 5. Upon Completion of Training Classes:
 - a. Videotaped record of all training
 - b. One copy of all training materials
- B. Shop Drawings:
1. General:
 - a. Drawings shall be prepared using computer aided drafting which can produce files compatible with AutoCAD version 2000 or later.
 - b. The final or record drawings will become permanent record drawings and shall be prepared on mylar matching the project Drawing sheet size.
 - c. Product data shall be submitted in a three-ring binder with all product information indexed and tabbed. The product data sheets shall be marked with the tag number as indicated by the drawings. All options, ranges and voltages that are to be provided shall be clearly indicated on each product data sheet.
 - d. Product data shall be submitted describing the operating systems associated with the DDC controllers and the workstations. Workstation software product data shall include information on the connectivity of the system using telephone and other supported means.
 2. Valve and Damper Schedules:
 - a. Damper schedules may be included on the drawings or in the product data. The damper schedule shall include the following information:
 - 1) Damper tag number
 - 2) System and service
 - 3) Quantity
 - 4) Size
 - 5) Manufacturer and model number
 - 6) Fail position
 - 7) Type (opposed or parallel blade)
 - 8) Actual pressure drop
 - 9) Quantity of actuators
 - 10) Actuator model number
 - 11) Actuator spring range

3. Drawings:
 - a. The drawing package shall include the following:
 - 1) Cover sheet with index listing all attached drawings.
 - 2) A diagram showing the network architecture and the true relationships of the panels on the network. This drawing shall include all network devices including; surge suppressors, lightning arrestors, repeaters, modems, gateways and routers. The power source, panel address, and physical location (room number) shall be shown for each device. External batteries or other power supplies shall be shown on this drawing.
 - 3) Control schematics and flow diagrams for each system monitored or controlled. These diagrams shall include:
 - a) A ladder diagram showing all wiring and pneumatic tubing associated with the controller. The location of the electrical power panel with breaker number shall be shown for all power sources.
 - b) Details showing the interconnection with motor starters, variable frequency drives and their associated bypass sections, chillers, boilers and other types of equipment. These details shall include wire numbers and terminal designations. The mounting locations of all control equipment shall be included.
 - c) A bill of materials shall be included with each control schematic. The bill of materials shall include the tag name used on the control drawing, description of the product, name of the manufacturer, complete model number, measurement range (if applicable) and quantity.
 - d) A complete input/output schedule for each DDC controller shall be included with each control schematic. The point name (the same one used in the software), and a functional description of the point shall be included in the I/O summary.
 - e) A sequence of operation shall be included with each control schematic. The sequence shall reflect actual programming, including all time delays and software interlocks. Copies of the sequence that appear in the Contract Documents is not acceptable.
 - f) Floor and roof plans showing the location of control panels, sensor, and mechanical equipment. The floor plans shall show the location of duct and space static pressure sample points.
- C. A software submittal shall be provided and include the following:
 1. Point listings shall include all hardware and software points. A description of the point shall be provided. The default values of each point shall be shown.
 2. Program listings for each piece of controlled equipment shall be provided. The program listing shall be complete with all data required for controller operation.
 3. Submit a color printout of each graphic. The graphic shall show temperature, status, position and all data points that will appear on the screen. At the contractor's option, the graphics may be submitted on CD or disk provided that all required software for the display of the graphics is also furnished.
 4. A listing of all alarms and the alarm limits and time delays shall be provided.
 5. Flow Charts shall graphically depict the control logic and algorithms as specifically tailored to this project. Every branch of the program shall be shown. All alarms, alarm limits, alarm messages and time delays shall be shown. Flow charts shall use industry standard symbols and the variable names shall appear on the flow chart.
- D. Quality Assurance/Control Submittals:
 1. A test plan shall be submitted and include the following:
 - a. Certification documentation for each hardware point. Certify that the point was tested and cycled to prove functionality. Include the calibration data, initial and final readings and the required offset.
 - b. Test data form for testing pneumatic tubing.

- c. Procedures for the seven-day test.
- d. Certification documentation for software sequence of operation.
- e. The test plan shall be coordinated with the Testing, Adjusting, and Balancing Contractor and the Commissioning Agent:

E. Closeout Submittals:

1. Project Record Documents:

- a. Upon completion of the installation, provide a complete set of record (as-built) drawings on a clear and legible set of Mylar transparencies. The content and format of the drawings shall be as described previously.
- b. Prior to final completion of the installation, prepare complete Operation and Maintenance (O&M) manuals. Refer to Division 01 and Division 23 for requirements. Also provide one set of magnetic media containing all CAD-prepared drawings in AutoCAD Version 2000 or higher. Format shall be .DWG files.
 - 1) Assist Division 23 Contractor in preparation of a simplified description of the operation of all systems including the function of each piece of equipment within each system. These descriptions shall be supported with a schematic flow diagram when applicable.
 - 2) Temperature control diagrams including an explanation of the control sequence of each system along with the following instruction wherever applicable.
 - a) Emergency procedures for fire or failure of major equipment
 - b) Normal starting, operating, and shutdown
 - c) Summer or winter shutdown
- c. The temperature control diagrams are to be wall-mounted under glass or plastic in an accessible location, preferably in the main mechanical equipment room.
- d. Control System Programmer's manual with complete description of the custom control language and associated editor, including sample-written programs. Provide complete sets of all programming forms, applications memorandums, and addenda to the programmer's manual. All software and firmware algorithms shall be completely described and documented.
- e. Maintenance, installation, and engineering manual(s) that clearly explain how to debug hardware problems; how to repair or replace hardware; preventative maintenance guidelines and schedules; calibration procedures; and how to engineer and install new points, panels, and operator interfaces.
- f. Documentation of all software: List separately all software parameters that may need updating by the Owner, such as, though not limited to, daily start/stop schedules; setpoints; alarm points; control loop cascade, and PID parameters, etc.
- g. All programs, code, databases, graphic files, CAD drawings, and symbol libraries generated for operation of the system shall be included as part of the system documentation. This information shall be submitted both in hard copy bound format and machine readable format (i.e., floppy disk or CD-ROM).
- h. Input/output schedules, data sheets, and all other items required. Describe all regular maintenance that will need to be performed on the DDC hardware. Provide list of recommended spare parts. List all replacement parts with part numbers.
- i. Complete original issue documentation, installation, operation manuals, and supporting software for all third-party hardware and software furnished and installed as part of the system or required for the operation of the system, including remote terminals, user's computer workstation, monitors, graphics and memory boards, network servers, printers, and modems.
- j. All software licenses, warranty certificates and documentation for all hardware and software including third party hardware and software shall be provided.
- k. All testing, startup, calibration and checkout reports and checklists.
- l. A list of recommended spare parts with part numbers and supplier.
- m. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.

1.6 SUMMARY

- A. Products furnished, but not installed by the temperature control contractor:
1. The automatic temperature control valves, separable wells for immersion sensors, and taps for flow and pressure instruments shall be provided by the Controls Contractor for installation by the Mechanical Contractor under the Controls Contractor's supervision.
 2. The Controls Contractor shall provide all automatic temperature control dampers for installation by the Mechanical Contractor under the Control Contractor's supervision.

1.7 SYSTEM DESCRIPTION

- A. Design Requirements:
1. The existing automatic temperature control system shall be expanded as required using electric and pneumatic components as required.
 2. All digital and analog control loops shall be microprocessor (DDC) controlled unless otherwise shown on the Drawings.
 3. The Temperature Control Contractor shall interface with all controls furnished with equipment. Provide additional control devices, interlock relays, and signal conditioners where necessary to accomplish specified sequences.
 4. The system shall include all interlocks, field devices, wiring, piping, hardware, and software required to provide a complete, functional system in accordance with the Contract Documents.
 5. Electrical wiring in connection with the automatic temperature control system, where shown on the Division 16 drawings, shall be performed by the Electrical Contractor. **All other wiring required for proper operation of the automatic temperature system shall be performed by the Temperature Control Contractor.**
 6. Adjustments of manual balancing devices, as required to obtain design air and/or water flows, shall be by the Balancing Contractor. The Temperature Control Contractor shall provide assistance to the Balancing Contractor with control adjustments to obtain design flows by:
 - a. Providing on-site instruction on the proper interfacing and operation of the control equipment
 - b. Providing the necessary software for use with the Balancing Contractor's personal computer for interfacing with the control equipment. Where proprietary software, equipment or gateways are required, this software, equipment or gateways shall be provided for the Balancing Contractor's use.
 7. The Control Contractor shall be responsible for startup of all equipment installed and/or modified under this section. The Control Contractor shall fully participate in the commissioning process and assist the Commissioning Agent with control demonstration and software adjustments, required for proper operation. The Control Contractor shall cooperate with the Commissioning Agent as to startup procedures, scheduling, performance verification, and system debugging. The Control Contractor shall also:
 - a. Provide on-site instruction on the proper interfacing and operation of the control equipment
 - b. Provide the necessary software for use with the Commissioning Agent's personal computer for interfacing with the control equipment. Where proprietary software, equipment or gateways are required, it shall be provided for the Commissioning Agent's use.
 - c. Provide any portable hand held setup/calibration devices required to initialize the control system for the Commissioning Agent's use.
 - d. Provide personnel to demonstrate the operation of the hardware and software during the commissioning process.

1.8 WARRANTY

A. Special Warranty:

1. The warranty period shall begin as authorized by the Owner's Representative in writing. Completion shall not occur before the Control Contractor has performed the tests required in Article 3.
2. The control system shall be warranted to be free from defects in material and workmanship and in software design and operation for a period of two years after completion of the contract. The Control Contractor shall provide the necessary skills, labor, and parts to ensure that all system and component failures are promptly repaired. This warranty shall become effective starting on the date of completion.
3. The Control Contractor shall receive calls during the warranty period for all problems or questions experienced in the operation of the installed equipment and shall take steps to correct any deficiencies that may exist. The response time to critical problems shall be four (4) hours maximum.
4. The Control Contractor shall maintain a backup of all software installed in the system. The backup shall be updated monthly or whenever a change to the software is made. A reload of backup software into the system shall be performed by the Control Contractor immediately upon notification by the Owner. The reload shall be free of charge unless it is due to a power failure of a duration longer than the battery backup.
5. The Control Contractor shall optimize all control software to ensure acceptable operating and space conditions and peak energy efficiency. This shall include changes needed to optimize operation of the systems even if not explicitly described in control strategies.
6. The Control Contractor shall provide and install at no extra cost all hardware, firmware, and software updates released prior to and during the warranty period. These updates shall be installed and fully implemented on every device to which they apply, throughout the project. Written authorization by the Owner must be obtained prior to the installation of these changes.
7. At the end of the warranty period, the Control Contractor shall supply updated copies of the latest versions of the "Project Record Documentation" as described under the "Submittal" section. This includes final updated drawings, software documentation, and magnetic media backups that include all changes that have been made to the system during the warranty period.

- B. The Control Contractor shall warranty all systems and equipment utilizing any hardware, firmware, or software against adverse performance previously described for a period of five years from the date of final acceptance of the entire work as identified in the General Conditions and shall guarantee to repair or replace at his own expense any part of the apparatus that may show defect during that time.

1.9 DEMONSTRATION AND TRAINING

- A. The Control Contractor shall provide a minimum of eight hours of system and control demonstration time at the job site for the Owner's personnel.
- B. The Control Contractor shall provide at least 8 hours of classroom training sessions at times and location as directed by the Owner. The training shall focus on design, operation, and maintenance procedures of the products installed and shall cover:
1. Hardware configuration including PC boards, switches, communication and point wiring, and location of all sensors and control devices
 2. Hardware maintenance, calibration, troubleshooting, diagnostics, and repair instructions
 3. Operation of central workstation, including logging on and off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, changing firmware and software parameters, and generating and linking graphic screens.
 4. The operational sequence of each system including normal and abnormal operating modes, operating control strategies, and operator actions required to reset or monitor the system.

5. Programming, using the editor, program design, syntax, compiling, and loading of custom control software
 6. Recovery procedures from power failures
 7. Alarm formats and assignment
 8. Maintaining software and programming backups
- C. The instructor(s) for the above sessions shall be employee(s) of the Control Contractor whose primary function is customer training and applications support.
- D. The Owner may elect to conduct training in four-hour sessions over the life of the warranty period. The full compliment of instructional material shall be available to each employee at each training session up to a maximum of ten (10) individuals.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

- A. All project-developed software and documentation shall become the property of the Owner. The Owner shall retain the right to duplicate and/or modify such for use at this facility. These documents shall not be copyrighted. These include but are not limited to:
1. Project graphic images
 2. Record drawings
 3. Project database
 4. Job-specific application programming code
 5. All project specific documentation

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Control Contrators
1. Setpoint
 2. Trane
- B. Regardless of the manufacturer, the specific products and design chosen shall meet the requirements of this specification.

2.2 PNEUMATIC TUBING

- A. Pneumatic tubing shall be bending temper copper or Type FR virgin polyethylene.
1. Exposed tubing shall be copper or Type FR in metal conduit.
- B. Fittings:
1. Copper Fittings:
 - a. Solder-type fittings shall be wrought copper sweat fittings sealed with 95% tin, 5% antimony solder as manufactured by Mueller Brass "Streamline;" Nibco, Inc.; or Chase Brass & Copper Co.
 - b. Compression-type fittings shall be Swagelok, Imperial-Eastman "Hi-Duty," or Parker Hannifin "CPI."

2. Plastic Tubing:
 - a. Compression-type fittings shall be Swagelok “KN,” Imperial-Eastman “Polyflow,” or Parker Hannifin “Poly-Tite.”
 - b. All barb-type fittings shall be brass.

C. Conduit for pneumatic tubing shall be per Division 16.

2.3 CONTROL WIRING

- A. Cables shall be shielded when so recommended by manufacturer. Conductor size shall be in accordance with manufacturer's recommendations subject to specified minimum size.
- B. All low-voltage control wiring in ceiling plenums, not in conduit, shall be UL listed for air plenum service.
- C. All insulated wire shall be copper conductors, UL labeled for 90°C minimum service.
- D. Conduit for wiring shall be per Division 16.

2.4 TRANSIENT VOLTAGE PROTECTION

- A. TVSS surge protectors, for incoming 120 VAC power to controllers: Leviton 51020WM, or Engineer-approved equal. Surge protectors furnished shall be UL 1449 listed. The maximum single-pulse transient current shall be 26kA, noise rejection at 50 ohms -40 to -50 for 5K to 100mhz, the cat B3 combination wave peak clamping voltage shall be L-N 300 V, L-G 350 V, the UL 1499 ratings shall be L-N330V, L-G 400V, Fault current rating (AIC rating assigned per UL) shall be 5,000A.
 1. Transient voltage protection for all twisted pair, telephone and coaxial data communication lines between controllers shall be per manufacturer recommendations. Provide all required repeaters to ensure signal integrity.
 2. Lightning arrestors on all communications and other lines that exit the building shall be per manufacturer recommendations.

2.5 CONTROL DAMPERS

- A. All control dampers shall be low leak parallel or opposed blade configuration with published leakage data certified under the AMCA certified ratings program.
 1. Leakage shall be less than 5.0 cfm per sq. ft. of area at 4-in. w.g. pressure difference through a 48” x 48” damper.
 2. The published leakage data shall include leakage rates for all available damper sizes at pressure differences from 1 in w.g. through 13 in w.g.
 3. Blade configuration shall be as indicated in the control diagrams in the Project Drawings.

- B. Materials:
1. Low leak dampers shall be constructed of 5" x 1" x 0.125" 6063T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame.
 2. Blades shall be airfoil type extruded 6063T5 aluminum with an integral structural reinforcing tube running the full length of each blade. Maximum blade depth shall be 6".
 3. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket that enables air pressure from either direction to assist in blade to blade seal.
 4. Blades shall be mechanically locked in extruded blade slots. Adhesive or clip-on type blade seals are not acceptable.
 5. Bearings shall be non-corrosive molded synthetic. Axles shall be square or hexagonal to provide positive locking connection to blades and linkage.
 6. Linkage shall be concealed in the frame.
- C. Actuators:
1. Damper actuators, electric or pneumatic, shall be as indicated on the Project Drawings.
 2. Damper actuators shall be Listed under UL 873.
 3. Damper actuator shall have a visual and electronic position indicator.
 4. Damper actuator housing shall be die cast aluminum.
 5. Damper actuator shall be provided with a spring return with minimum close time of 15 seconds and maximum close time of 30 seconds. Spring return shall be configured as follows:
 - a. Outside air damper shall fail normally closed.
 - b. Return air damper shall fail normally open.
- D. Control damper basis of design is Ruskin CD50. Control actuator basis of design is Seimens GCA series.

2.6 LOCAL CONTROL PANELS

- A. All indoor control cabinets shall be fully enclosed NEMA 1 construction with hinged door, key-lock latch, baked enamel finish, removable subpanels, wall-mounted or freestanding. All temperature control panels on the project shall be keyed alike.
- B. All outdoor control cabinets shall be fully enclosed NEMA 12 construction with hinged door, external key-lock latch, baked enamel finish, removable subpanels, wall-mounted or freestanding. All temperature control panels on the project shall be keyed alike.
- C. Panels shall house the microprocessor, modem, communication interface, all controllers (except those required at VAV boxes), relays, indicators, transmitters, switches, pilot lights, override timers, etc., to allow quick access for adjustment and troubleshooting.
- D. Manual switches and indicating devices shall be flush-mounted on panel face. Provide engraved plastic or lithographed metal nameplates for all items on the panel face.
- E. Internal components shall be securely mounted on removable subpanels. Each component shall be individually labeled with function and device identification, as shown on control/interlock shop drawings.
- F. Interconnections between internal and face-mounted devices prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminal blocks shall be provided for all field connections, and shall be UL listed for 600-volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring.
1. Control terminations for field connection shall be individually identified per control drawings.
 2. All internal wiring between panel mounted devices and field terminal blocks shall be marked on both ends with the appropriate identifying tag.

- G. Provide on/off power switch with over-current protection and main air gauge for control power sources to each local panel.

2.7 ACTUATORS AND POSITIONERS - PNEUMATIC

- A. Pneumatic actuators shall be piston-rolling diaphragm type or diaphragm type with easily replaceable, beaded, molded neoprene diaphragm.
 - 1. Actuator housings may be molded or die-cast zinc or aluminum. Round "can" type metal and/or non-metallic actuators are not acceptable. Exception: Actuator housings for terminal unit zone control dampers or valves may be of high-impact plastic construction with ambient temperature rating of 50 to 140°F minimum. However, any plastic devices located in return air (ceiling) plenums shall be isolated from plenum with an auxiliary metal enclosure having quick-opening access panel.
 - 2. Actuator size and spring ranges selected shall be suitable for intended application.
 - a. Damper actuators shall be selected per manufacturer's recommendations to provide sufficient close-off force to effectively seal damper and to provide smooth modulating control under design flow and pressure conditions. Furnish a separate actuator for each damper section.
 - b. On sequencing applications, valve and damper actuators shall be sized for a maximum of 2 psi shift in nominal spring range and ranges selected to prevent overlap, or positive positioners shall be provided.
 - c. Positive positioners shall be provided on actuators for inlet vane control and on any other actuators where required to provide smooth modulation or proper sequencing.
- B. Positive positioners shall be high-capacity force balance relay type with suitable mounting provisions and position feedback linkage tailored for particular actuator.
 - 1. Positioner shall reposition actuator on an input (pilot) signal change of 1/4 psi or less. Repeat accuracy - $\pm 3\%$.
 - 2. Positioner start point shall be adjustable from 2 to 12 psi minimum.
 - 3. Positioner span shall be adjustable, or at least three fixed spans (3, 5, and 10 psi) shall be available.

2.8 CONTROL DEVICES - ELECTRIC

- A. Pressure-Electric (PE) Switches:
 - 1. Shall be metal or neoprene diaphragm actuated, operating pressure rated 0-25 psig, with calibrated scale setpoint range of 2 to 18 psig minimum, UL listed.
 - 2. Provide one- or two-stage switch action SPDT, DPST, or DPDT, as required by application. Electrically rated for pilot duty service (125 VA minimum), and/or for motor control.
 - 3. Differential shall be fixed or adjustable as required by application, typically:
 - a. Transmitter signals: 0.1 to 0.2 psi, fixed
 - b. Fan/pump control: 2 to 6 psi, adjustable
 - c. Interlock functions: 2 psi, fixed
 - 4. Shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
 - 5. Furnish permanent indicating gauge on each pneumatic signal line to PE switches.
- B. Electro-Pneumatic (EP) Solenoid Air Valves:
 - 1. Shall be snap-acting, three-way air valve with three ports (common, N.O. and N.C.), UL listed.
 - 2. Provide bronze or plastic body with stainless steel trim. Minimum safe pressure shall be 30 psig at 130°F ambient and 130°F control air temperatures.
 - 3. Coil voltage as required up to 460 VAC.

4. Provide open type (panel-mounted) or enclosed type for remote installation. Enclosed in type NEMA 1 unless otherwise specified.

C. Signal Conditioning Relays:

1. Shall be high-volume relay type or low-capacity restricted supply type as required by application.
2. Zero, start, and/or span adjustments shall be provided when required by application.
3. Shall be located in local control panels with function clearly identified.
4. Provide test ports (or gauges) for all inputs and gauges for all outputs.

D. Electro-Pneumatic (EPT) and pneumatic-electric (PET) Transducers:

1. Shall accept industry standard inputs and provide standardized outputs.
 - a. Pneumatic signals: 3 to 15, 1 to 18 or 0-20 psig.
 - b. Electric signals: 4 to 20 ma, 1 to 5, 0 to 10VDC.
2. Units shall be linear plus or minus 1% over specified input/output range at ambient temperatures of 40 to 120°F.
3. Span (calibration) and start point shall be fully adjustable.
4. Shall have no bleed air consumption and shall be complete with pressure gauge and be open type for panel mounting, or provided with NEMA 1 enclosure for remote mounting unless otherwise specified. With power removed the branch air pressure shall drop to 0 psi. If the branch pressure locks in upon power failure an EP shall be provided on each output to bleed to 0 psi.

E. Indicating Gauges and Test Ports:

1. Control signal indicating and test gauges shall be 1-1/2 inches, back-connected, 0-30 psig.
2. Test ports shall be quick-disconnect type using needle probe or threaded pin valve type.
3. Permanent indicating gauges shall be furnished for all pneumatic transducer, EP, and relay outputs used to position actuators or PE switches. Gauges shall be in local control panels when applicable. Test ports shall be provided for all EP, relay, and signal conditioning inputs that do not directly signal actuators. One main (supply) air pressure gauge shall be installed in each local control panel.

2.9 TRANSMITTERS - SOLID-STATE

A. Transmitters shall have sensing elements suitable for application.

B. Transmitters shall have direct-acting, linear output signal compatible with controller, with full scale accuracy as described below. Zero and span shall be field-adjustable.

1. Transmitter range (span) shall be suitable for application, typically as follows:
 - a. Static Pressures:
 - 1) Building S.P. -0.1 inch to +0.1 inch w.g.
 - 2) Supply duct S.P. 0 inch to 3 inch w.g. or 1.0 inch to 4 inch w.g.
2. Transmitter sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.
3. Differential pressure transmitters for space and duct static pressure shall have 1% FS accuracy, \pm 1.0% stability (F.S./year), 250msec response time, 5 psig proof pressure, 4 - 20 mA output, non-interactive zero and span adjustments, Ashcroft, Air Monitor, or Engineer-approved equal.

C. Transmitter Accessories:

1. Provide wind dampening "weatherhead" for outdoor atmospheric pressure sensing. Dwyer A-306 or Engineer-approved equal.
2. Indoor space static pressure sensor locations shall use a blank thermostat cover with mounting frame or Engineer-approved equal.

2.10 AUXILIARY DEVICES - ELECTRIC

- A. Damper end switches shall be UL listed, line voltage SPDT snap-acting, pilot duty rated (125 VA minimum) NEMA 1 enclosure, with roller type actuating arm suitable for damper position application.
- B. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage suitable for application. Idec series RH-L, ULAC or Engineer-approved equal. Provide diodes to limit back EMF on all DC relays and MOVs on AC.
- C. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 enclosure when not installed in local control panel. Seimens series CK or Engineer-approved equal.
- D. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
- E. Manual control switches shall be UL listed for use in NEMA 1 enclosures with contact arrangement and rating suitable for application. Bat handle or knob actuator with nameplate clearly identifying function of each switch position.
- F. Manual position adjusters shall be potentiometer type with adjustment knob and calibrated dial.
 - 1. Manual positioners shall have start-point and span consistent with actuator range. Dial scale marked "Open-Close" with intermediate graduations.
 - 2. Minimum positioners shall provide for manually adjustable minimum position (0 to 100%) with override from auxiliary (pilot) signal input. Adjustable start point with span consistent with actuator range. Dial scale marked "Minimum Position" with graduations for 0 to 100% setting.
- G. Override timers shall be spring-wound line voltage UL listed, contact rating and configuration as required by application. Provide 0 to 6 hour calibrated dial unless otherwise specified; suitable for flush mounting on control panel face, located on local control panels or where shown on plans.
- H. Current-operated switches shall be self-powered, solid state split core with manually adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system. Where used in conjunction with variable frequency drives the current operated switch shall be recommended for such service by the manufacturer. The Current switch shall have a maximum hysteresis of 0.01A in the 1.5A to 6 amp range. manufacturers: Neilsen-Kuljian, Veris Industries or Engineer-approved equal.
- I. Current transducers shall be 4-20 ma output solid state with $\pm 0.5\%$ of full scale accuracy. Unit shall have reverse voltage protection, and a flat frequency response from 20 to 100 Hz. The range shall be selected to meet the application. manufacturers: Neilsen-Kuljian AT-420, Veris Industries Hawkeye 720, or Engineer-approved equal.
- J. Power Supplies:
 - 1. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 MV maximum P-P. Regulation shall be 0.10% line and load combined, with 50-microsecond response time for 50% load changes. Unit shall have built-in over voltage protection.
 - 2. Unit shall operate between 0°C and 50°C. EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL Standard 810C for shock and vibration.
 - 3. Unit shall be UL recognized.
 - 4. Sola or Engineer-approved equal.

2.11 ACTUATORS AND POSITIONERS - ELECTRIC

A. Externally mounted damper actuators

1. Electronic direct-coupled actuation shall be provided.
2. The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable.
3. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
4. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
5. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
6. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal.
7. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.
8. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque capacity shall have a manual crank for this purpose.
9. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
10. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
11. Actuator size and rating shall be suitable for intended application.
12. Damper actuators shall be selected per manufacturer's recommendations to provide sufficient close-off force to effectively seal damper. Modulating actuators shall provide smooth modulating control under design flow and pressure conditions. Furnish a separate actuator for each damper section.
13. Actuators shall be Underwriters Laboratories Standard 873 listed.
14. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty. Manufacturer shall be ISO9001 certified. Actuators shall be as manufactured by BELIMO or Engineer approved equal.
15. Approved manufacturers/models are:
 - a. Honeywell M600, M700, M800, M900 series
 - b. Johnson M100 series, DA3000 series
 - c. Belimo
 - d. Siebe

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment can be installed as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.2 CONTROL AIR PIPING

- A. All control air piping shall be concealed except in equipment rooms or unfinished areas. Installation methods/materials as follows:
 - 1. Concealed and Inaccessible: Copper tubing without joints or FR plastic in metal raceway. Exceptions: Room thermostat drops in stud walls may be FR plastic tubing in areas with lay-in ceiling. Lines buried in concrete must be in metal conduit.
 - 2. Concealed and Accessible (including ceiling return air plenums): Copper tubing (ACR) or FR plastic tubing. Limitations:
 - a. FR tubing shall be enclosed in metal raceway when required by local code.
 - b. Quantity of FR tubing per cubic foot of plenum space shall not exceed manufacturer's published data for Class 1 installation.
 - c. Where FR tubing is used without raceway, tubing shall be supported from or anchored to structural members. Tubing shall not be supported by or anchored to electrical conduits, or ceiling suspension systems.
 - 3. Concealed and Accessible (including ceiling return air plenums): Copper tubing (ACR) or FR plastic tubing metal raceway.
 - 4. Exposed: Hard-drawn ACR copper or FR plastic in metal raceway.
 - 5. Final Connections:
 - a. Where copper tubing is used, a short section (18-inch max.) of FR plastic tubing is acceptable for final connection to the control device. However, a copper to barb or a compression type fitting shall be used at the junction; plastic slipped over copper tubing is not acceptable unless tubing clamp is also used.
 - b. Where FR plastic tubing exits a raceway or junction box, a maximum of 18 inches of exposed FR tubing is acceptable for final connection to the control device.
 - 6. Pneumatic tubing shall not be run in raceway containing electrical wiring.
 - 7. Where FR tubing exits the end of raceway or junction box, provide a snap-in nylon bushing (Johnson, Part #F-1000-331 or equal). Where pneumatic tubing exits control panels, provide bulkhead fittings. Where copper tubing exits junction boxes or panels, provide bulkhead fittings.
 - 8. Support copper tubing 3/8-inch diameter and less at intervals not exceeding 48 inches.
 - 9. Solder or braze copper tubing or use compression fittings
 - 10. Compression type fittings shall be used on all polyethylene tubing carrying more than 30 PSI. Brass barbed-fittings or compression type fittings shall be used on all polyethylene tubing carrying 30 psig or less.
- B. All control air piping shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Piping above suspended ceilings shall be supported from or anchored to structural members or other piping and/or duct supports. Tubing shall not be supported by or anchored to electrical conduits or ceiling suspension systems.

- C. Maintain a minimum of 8-inch clearance between high temperature equipment (e. g. steam pipes, flues, etc.) and all plastic tubing.
- D. Pressure test all low pressure control air piping at 30 psi for 24 hours prior to connection to control devices. High pressure piping shall be tested at 150 psig. Test fails if there is a loss of more than 5 psi. Provide pressure test certification to the Engineer.
- E. Vertical runs of main or high pressure control air piping greater than 15 feet shall be copper. Vertical runs of branch control air piping greater than 30 feet shall be copper.
- F. Purge tubing with dry, oil-free compressed air before connecting control instruments and devices.

3.3 CONTROL WIRING

- A. All control and interlock wiring shall comply with the national and local electrical codes and Division 16 of these specifications. Where the requirements of this section differ with division 16 the more restrictive requirements shall take precedence. Control wiring shall be concealed except in equipment rooms.
- B. All Power (line voltage) and Class 1 wiring shall be UL listed in approved raceway per NEC and Division 16 requirements.
- C. All Power limited circuits (Class 2 or Class 3) shall be UL listed in approved raceway per NEC and Division 16 requirements.
- D. All Power limited circuits (Class 2 or Class 3) shall also be in metal raceway, except as follows:
 - 1. Concealed and accessible locations including ceiling return air plenums: Approved cables not in raceway may be used provided that:
 - a. Circuits meet NEC Class 2 or Class 3 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 or Class 3 current-limit.)
 - b. All cables shall be UL listed for application, i.e. Cables used in ceiling plenums shall be UL listed specifically for that purpose.
- E. Approved Cables not installed in raceways shall be subject to the following :
 - 1. Install wiring in sleeve where wiring passes through walls and floors. Maintain the fire rating (if any) at all penetrations.
 - 2. Cables shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, or ceiling suspension systems. All plenum cable and installation shall comply with the requirements of the NEC.
 - 3. Network data cables shall be identified with permanent labels installed every 12 feet.
 - 4. Exposed splices shall not be permitted. Cable shall be installed without splices between terminal points.
 - 5. Maintain a minimum of 6 inches from high temperature equipment (e. g. steam pipes, flues, etc.).
- F. All cable conductors shall be minimum 18 AWG stranded, except 19 AWG may be used for home runs to central control panels, and minimum 22 AWG, twisted pairs for resistance type sensors and/or data communication cables. Cables shall be shielded when so recommended by the manufacturer. Line voltage power and interlock wiring conductors shall be THHN, 14-gauge minimum. Size wire in accordance with NEC.
- G. All wiring shall be installed as continuous lengths with no splices permitted between termination points.
- H. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Install without splices between terminal points.

- I. This Contractor shall terminate all control and/or interlock wiring and maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- J. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3 feet in length and shall be supported at each end. Flexible metal conduit less than 1/2-inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.
- K. Provide conduit seal-offs where portions of an interior raceway system pass through walls, ceiling or floors which separate adjacent rooms having substantially different maintained temperatures or when a raceway goes from indoors to outdoors.
- L. Wiring for analog inputs shall not be run in conduit containing 120 VAC wiring or any wiring that carries switched signals or any noise-generating sources.
- M. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring. When plenum cable is not allowed, network or communication wire shall be installed in a dedicated raceway. Other wiring in communications raceway is not allowed.

3.4 TRANSIENT VOLTAGE PROTECTION

- A. This Contractor shall provide and install:
 1. Transient voltage protection, on all incoming 120 VAC power to all controllers (except VAV controllers).
 2. Transient voltage protection for all twisted pair, and coaxial data communication lines between controllers. Provide all required repeaters to ensure signal integrity.
 3. Transient voltage protection on all phone lines.
 4. Lightning arrestors on all communications and other wiring that exit the building. Locate the arrestor at the point of building entrance.
 5. Provide ground connection sized and installed in accordance with the manufacturers instructions.

3.5 CONTROL DEVICE LOCATIONS

- A. Room thermostats and sensors shall be mounted for ADA Compliance.
- B. Remote control devices not in local panels shall be accessible for adjustment and service -- below 6 feet above the finished floor whenever possible.
- C. All analog pressure and differential pressure transmitters for air service shall be located in the DDC control panels. Mounting air pressure transducers at the ductwork is not acceptable.
- D. Seal the wall opening and wire penetration of all wall mounted temperature sensors to prevent airflow from the wall cavity, from affecting the sensor reading.

3.6 CONTROL PANELS

- A. Field wiring to panels shall be enclosed in metal raceway.
- B. Panels shall be mounted at eye level for accessibility and service.
- C. Local control panels shall be located within 50 feet of system served unless otherwise shown on plans.

- D. Mount panels on solid non-vibrating surfaces in areas free from moisture or water accumulation. Where such surfaces are not readily accessible, mount the panel on rigid unistrut stand attached to the floor. The sides of ducts and air handling units are not acceptable mounting surfaces.
- E. Control devices shall be installed in panels. Electro-pneumatic switches (EPs) shall be grouped together and installed in panels (Usually, only one enclosure per equipment room.). Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. Control relays shall not be located within Class 1 starter enclosures. At the contractor's option, the relays and EPs may be installed in the same enclosure as the controller.

3.7 FIELD DEVICE INSTALLATION

- A. Actuators: Mount and link control damper actuators per manufacturer's instructions.
 - 1. To compress seals when spring return actuators are used on normally closed dampers, power actuator to approximately a 5 degree open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- B. Air Pressure Sensors:
 - 1. Install duct static pressure sensing device (static tip) in the center of ductwork at least 3 diameters upstream and downstream from any obstructions.
 - 2. Install space static pressure sensor in ceiling where located on the drawings.
 - 3. Install outdoor static reference sensor on the roof away from obstructions. Install and locate in accordance with the manufacturer installation instructions.

3.8 IDENTIFICATION

- A. All control equipment shall be clearly identified by control shop drawing designation as follows:
 - 1. Control valves - brass tags.
 - 2. Other remote control devices and sensors: metal tags; plastic laminate labels; or, on non-porous surfaces only, permanent label tape as produced by the Brother "Easy Touch" label maker. Do not attach tag or label to removable covers, etc. Rivet or stick to device or adjacent surface.
 - 3. Control panel doors - engraved nameplate with panel number and systems served.
 - 4. Devices in control panels: engraved plastic tags; metal tags; or, on non-porous surfaces only, permanent label tape as above, mounted to panel adjacent to control device. 1/4-inch high letters minimum
 - 5. All wiring, including wiring within factory-fabricated panels, shall be labeled within 2 inches of termination with DDC point number/controller number or other descriptive information.
 - 6. All pneumatic tubing shall be labeled within 2 inches of termination with a descriptive identifier.
 - 7. All metal and plastic engraved labels shall be secured with chains, nylon tie-wraps, or rivets. Screws with exposed threads are not acceptable. Permanent adhesive is acceptable only when mechanical fasteners would damage the labeled equipment.
 - 8. All switches, relays, and panel components shall be labeled. Relays shall be labeled such that removal of the relay does not move the label.
 - 9. Raceway identification: For ease of identification, junction and pull box covers shall be color coded. Coordinate the color of the junction box covers with Division 16 and the Owner.

3.9 PROTECTION

- A. The Contractor shall protect all work and material from damage by his work or workmen, and shall be liable for all damage thus caused.

- B. The Contractor shall be responsible for work and equipment until finally inspected, tested, and accepted; he shall protect work against theft, injury, or damage; and shall carefully store material and equipment received on site that is not immediately installed. He shall close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.10 CLEANUP

- A. At the completion of work, all equipment provided by this section shall be checked and thoroughly cleaned including under equipment and any and all other areas. Clean exposed surfaces of all equipment and panels of all grease, plaster, or other foreign material. Remove all stick-on labels and clean surfaces.
- B. At the completion of the work, remove from the building, the premises, and surrounding streets, alleys, etc., all rubbish and debris resulting from work performed under this section and leave all equipment spaces absolutely clean and ready for use.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet, jacket, or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.11 TESTING

- A. Prior to substantial completion, the control system shall undergo a series of tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed their own performance tests.
- B. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, startup, and debugging process. Control system testing shall be coordinated with the Commissioning Contractor and scheduled with the Owner's representative.
- C. The Contractor shall provide at least two men equipped with two-way communication, and shall test actual field operation of each control and sensing point for all modes of operation including day, night, summer, winter, occupied, unoccupied, fire/smoke alarm, and power failure modes. The purpose is to test the calibration, response, and action of every point. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor. The Commissioning agent and the Owner's Representative (at their discretion) may observe and review these tests.
 - 1. The system software shall be complete such that each control loop shall function as specified in the Sequence of Operation. This contractor shall be required to furnish the software program and test the operation of every branch and control loop.
 - 2. This contractor shall be responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the letter and intent of the specification. Control performance criteria is specified in the sequence of operations.
- D. A point to point verification shall be made for each input and each output to the system. The check shall include the operator workstation such that the correct point assignment at the workstation is also verified. The calibration of all input and output points shall be tested, documented and adjusted as needed.
- E. The operation of each hardwired safety and interlock shall be tested. This testing shall verify the correct operation of the safety or interlock in the hand and automatic modes of operation.
- F. Each alarm shall be tested. the receipt of the correct alarm message shall be verified for each alarm and device receiving the alarms. Dial out alarms shall be verified.

- G. Power failure restart and software backup during power failure shall be tested.
- H. Demand limiting (where used): The contractor shall supply trend data output showing the action of the demand limiting algorithm. The interval selected shall cover a time period when load shed is active. The data shall document the action on a minute-by-minute basis over at least a one hour period. Included in the trend shall be building KW, demand limiting setpoint, and the status of sheddable equipment outputs.
- I. Operational logs for each system that indicate all setpoints, operating points, valve/damper positions, mode, and equipment status shall be submitted to the Architect/Engineer. These logs shall cover a 48-hour period and have a sample frequency of not more than ten minutes. The data collection start time and sample frequency shall be the same for each point on a given system. Outdoor air temperature and humidity shall be included with each log. Digital points shall indicate the on condition as 100% and the off condition as 0%. The logs shall be provided in graphical format with sufficient resolution to see the ten minute data intervals. All points associated with a system including start and status points shall be included on the same graph. The logs shall also be submitted in text format on disk.
- J. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point which represents a change of actuator position of at least 25 percent of its full range. The sampling rate of the trend shall be from one second to three minutes depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and the controlled variable values. Any loop that yields unreasonably under or over damped control values shall require further tuning by the contractor.
- K. There shall be a seven day demonstration test. During a seven-consecutive day period, the system shall function in automatic mode without any overrides or operator intervention. Failure of any components, control sequences or the inability to deliver uninterrupted services shall be deemed a failure of the test. This contractor shall submit system logs demonstrating a successful test.
- L. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this section have been performed to the satisfaction of both the Engineer and Owner and all required documentation has been submitted and successfully reviewed. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative. Such tests shall then be performed as part of the warranty.
- M. After the system has operated properly for 90 days following startup of the final component of the heating and air conditioning systems, an as-built copy of the software shall be transmitted to the Owner for permanent record purposes. Any software upgrading or enhancements to improve the system operation or as required for proper operation of the system during the first year of operation is the responsibility of this Subcontractor. Any changes to the software shall be immediately transmitted to the Owner, and shall be installed at the job site by the Controls Contractor.

3.12 CONTROL EXECUTION - GENERAL

- A. This Contractor shall provide all required control interface relays, including control contactors for single-phase pumps and fans (1/2 hp or less) and any isolation relays required for interface to three-phase magnetic starter control circuits. All power wiring to single-phase motors and three-phase starters by Division 16; all control function (interlock) wiring by the Controls Contractor.
- B. This Contractor shall be responsible for providing control power to all his controllers and devices requiring control power including installation of any required breakers, unless such wiring is shown on the Division 16 drawings.
- C. Accessibility: Install all control devices in readily accessible locations as defined by Chapter 1, Article 100, Part A of the NEC.

- D. Hand-Off-Auto switches at the MCC shall energize equipment in both the 'hand' and 'auto' mode (when auto is commanded on for auto mode). Safeties shall protect equipment in the hand and auto modes. Where fans are interlocked with damper end switches, the hand and auto positions shall open the dampers and the damper end switch shall energize the fan.

- E. Safety Shutdowns - Boilers and Chiller: Boilers and/or chiller will be provided with all required safety controls as specified in Division 15. Safety trip shall shut down respective boiler or chiller and shall be annunciated at the central workstation.
 - 1. A break-glass boiler power off switch shall be installed adjacent to each boiler room personnel door per ASME CSD-1-1995.

END OF SECTION 23 30 00

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS:

- A. All drawings and specifications associated with the entire project, including the General Conditions of the Contract for Construction, General and Supplementary Conditions, and Division-01 specification sections shall apply to the Division 26 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with all Contract Documents associated with the project.
- B. Where contradictions occur between this section and Division 1, the more stringent requirement shall apply.

1.2 SUMMARY:

- A. Section Includes:
 - 1. Electrical equipment coordination and installation
 - 2. Sleeves for raceways and cables
 - 3. Sleeve seals
 - 4. Common electrical installation requirements

1.3 SUBMITTALS

- A. Product Data: For sleeve seals.

1.4 PROJECT SEISMIC REQUIREMENTS:

- A. All fire protection systems shall be installed to meet NFPA and IBC Seismic requirements.
 - a. Where any conflicts arise the more stringent requirements shall be applicable.
 - b. The design of the seismic requirements shall be the responsibility of the contractor.
- B. Installation shall comply with the local seismic requirements for the area of installation. Provide restraints, bracing, anchors, vibration isolation, seismic snubbers, and all other components required for the installation.

1.3 ELECTRICAL INSTALLATIONS:

- A. Drawings are diagrammatic in character and do not necessarily indicate every required conduit, box, fitting, etc.
- B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.
- C. Before any work is begun, determine that equipment will properly fit the space and that conduit can be run as contemplated without interferences between systems, with structural elements or with the work

of other trades.

- D. Verify all dimensions by field measurements.
- E. Where mounting heights are not detailed or dimensioned, install electrical conduits, boxes, and overhead equipment to provide the maximum headroom possible. In general, keep installations tight to structure.
- F. Make allowance for building expansion and contraction as it relates to all building electrical components and conduit systems that are subject to such.
- G. Develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers contract drawings shall be for system design intent and general configurations.

1.4 ACCESSIBILITY:

- A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc. that require replacement or servicing.
- B. Extend all conduits so that junction and pull boxes are in accessible locations.
- C. Provide access panel or doors where equipment or boxes are concealed behind finished surfaces.

1.5 COORDINATION:

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations
 - 3. To preserve headroom and keep openings and passageways clear, so all equipment is serviceable
 - 4. To allow right of way for piping and conduit installed at required slope.
 - 5. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials. Any cutting and patching made necessary by failure to provide measurements, drawings and layouts at the proper time shall be done at no additional cost in contract sum.
- E. Coordinate the installation of electrical materials and equipment above and below ceilings with suspension system, luminaires and other building components. Ductwork and piping shall not be installed above electrical panelboards, switchboards, motor control centers, and transformers.

1.6 DESIGN WORK REQUIRED BY CONTRACTOR:

- A. Systems or subsystems which require design responsibility by the contractor include but are not limited to:
 - 1. Final coordinated distribution systems within the ceiling cavity.
 - 2. Any system not fully detailed
 - 3. Fire alarm shop drawings
 - 4. Equipment supports, hangers, anchors and seismic systems not fully detailed nor specified in these documents, or catalogued by the manufacturer.
 - 5. Seismic restraint systems

1.7 PROJECT CONDITIONS:

- A. The contractor shall be required to attend a pre-bid walk-thru if required and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.
- B. Field verify all conditions prior to submitting bids.
- C. Report any damaged equipment or systems to the Owner prior to any work.
- D. Protect all work against theft, injury or damage from all causes until it has been tested and accepted.
- E. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the RTD Project Manager, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.
- F. Coordinate all services shut-down with the Owner. Provide temporary services if work cannot be completed after hours. Coordinate any required disruptions with Owner one week in advance.

1.8 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Execute and inspect all work in accordance with Underwriters Laboratories (UL), and all local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the more stringent requirement shall be followed. Follow application sections and requirements and testing procedures of Federal and State regulations, OSHA, NFPA, IEEE, NEMA, CBM, ANSI, NECA, ICEA and IETA.
- B. All material used on this project shall be UL listed and labeled and be acceptable to the authority having jurisdiction as suitable for the use intended.

1.9 PERMITS AND FEES:

- A. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.

1.10 TEMPORARY FACILITIES:

- A. Responsibility for providing temporary electricity, heat and other facilities shall be as identified in these specifications, as shown on the drawings and as specified in Division 1.

1.11 PRODUCT OPTIONS AND SUBSTITUTIONS:

- A. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.
 - B. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture.
 - C. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
- 1.12 ELECTRICAL SUBMITTALS:
- A. General
 - 1. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 Section covering shop drawings, product data, and samples for submittal definitions, requirements, and procedures.
 - 2. The submittals shall be submitted as a fully complete package identified by the specification section. The cover shall be identified with the job name, Owner's project number, date, Prime Contractor's name, etc. Submittals that are not complete with the required information will be sent back to be corrected.
 - 3. An index shall be provided which includes:
 - a. Product
 - b. Plan Reference (if applicable)
 - c. Specification Section
 - d. Manufacturer and Model Number
 - 4. Provide electronic submittals unless it is determined that hard copies are required.
 - 5. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.
 - 6. Submittals shall be provided for review within four (4) working weeks from award of contract to successful bidder.
 - C. The manufacturer's material or equipment listed first in the specifications or on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the first names, the cost of any changes in construction required by their use shall be borne by this Contractor.
 - G. Before starting work, prepare and submit to the RTD Project Manager/Engineer shop drawings and descriptive product data. Continue to submit in the stated format after each RTD Project Manager/Engineer's action until a "No Exception Taken" or "Make Correction Noted" action is received with the exception of fire alarm submittals which must be submitted until a "NO EXCEPTION TAKEN" action is received. Submittals shall include the following specified materials and, in addition, any materials not listed below but which are specified in the individual sections of Division 16 which follow.
 - 1. Raceways including surface raceways.

2. Cabinets, boxes, fittings, etc.
 3. Grounding
 4. Overcurrent protective devices
- H. The Design Professional's review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:
1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
 2. Construction means or methods
 3. Coordination of the work with other trades
 4. Construction safety precautions
- N. Mark submittals with designations as shown on the drawings and identify as required by Specification Sections. Identification shall contain the information as required in details and each label shall be submitted in list form with disconnects, MCC's, panelboards, switchboards, overcurrent protection devices and utilization equipment.
- 1.13 DELIVERY, STORAGE AND HANDLING:
- A. Refer to the Division 1, Sections on Transportation and Handling and Storage and Protection.
 - B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
 - C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.
 - D. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.
- 1.14 CUTTING AND PATCHING:
- A. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
 - B. When coring is required or identified, an x-ray of the area is to be taken prior to the performance of the work operation. X-ray work requires an MOP and protection.
 - C. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 - D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- 1.15 TESTING:
- A. Submit test reports as outlined in Division 1 Sections on Quality Control Services and each Division 26 Section.
 - B. Testing as required by these specifications shall pertain to all equipment, wiring, devices, etc. installed under this contract and being reused.

C. General Scope:

1. Perform all tests and operational checks to assure that all electrical equipment, both Contractor and Owner-supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.
2. The tests and operational checks shall determine the suitability for energization.
3. Schedule tests and give a minimum of two weeks advance notice to the RTD Project Manager. Reschedule testing for Owner convenience if required.

1.16 RECORD DOCUMENTS:

- A. Refer to the Division 1 Section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices, and any other relevant deviations from the Contract Documents.
- C. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.
- D. Mark schedules including panelboard, switchboard, motor control center, mechanical, kitchen and similar equipment schedules on drawings to indicate installed equipment and materials used, and any deviations or revisions to electrical load data and calculations.
- E. During construction, the contractor shall maintain at the job site a set of updated construction documents for the singular purpose of recording the above information. All record drawings shall be completed in erasable pencil. These changes shall be updated weekly.
- F. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme.
 1. Red shall indicate new items, deviations and routing.
 2. Green shall indicated items removed or deleted.
 3. Blue shall be used for relevant notes and descriptions.
- G. At the completion of the project, submit these documents to the RTD Project Manager/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the RTD Project Manager/Engineer.

1.17 OPERATION AND MAINTENANCE DATA:

- A. Refer to the Division 1 Section on project closeout or operation and maintenance data for procedures and requirements for preparation and submittal of maintenance manuals.
- B. In addition to the information required by Division 1 for Maintenance Data, include the following information:
 1. Description of function, normal operating characteristics and limitations, fuse curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.
 5. Complete list of parts and wiring diagrams.

6. Names, addresses and telephone numbers of the Contractor, Sub-contractors and local company responsible for maintenance of each system or piece of equipment.
7. All information shall be permanently bound in a 3-ring binder. The job name and address and contractor's name and address shall be placed on the cover and spine of each binder in a permanent manner. Dymo-tape is not acceptable.
8. Copies of all test reports shall be included in the manuals.
9. Provide manuals with dividers for major sections and special equipment. Mark neatly in ink the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
10. Final Schedule of Values with all Electrical (and Information Technology) change order costs included and identified.

C. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, and final Schedule of Values with all Electrical and Information Technology change order costs included and identified is provided and the manual is reviewed by the RTD Project Manager/Engineer.

1.18 WARRANTIES:

- A. Refer to the Division 1 Section on Warranties and Bonds for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.
- B. Compile and assemble the warranties specified in Division 26, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item. Information to include product or equipment description, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.19 CONSTRUCTION REQUIREMENTS:

- A. The contractor shall maintain and have available at the jobsite current information on the following at all times:
 1. Up to date record drawings.
 2. Submittals
 3. Site observation reports with current status of all action items.
 4. Test results; including recorded values, procedures, and other findings.
 5. Outage information.

PART 2 - PRODUCTS:

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
- D. Minimum Metal Thickness:
 1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 2. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

- E. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- F. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- G. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.5 EQUIPMENT HOUSEKEEPING PADS:

- A. Provide 4" concrete housekeeping pad for all floor mounted equipment including, but not limited to: switchgear, switchboards, motor control centers, floor mounted distribution panelboards, floor mounted branch panelboards, and floor mounted dry type transformers. Fabricate pads as follows:
 - 1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 4" larger in both directions than the overall dimensions of the supported unit.
 - 2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
 - 3. Place concrete and allow to cure before installation of units. Use Portland cement that conforms to ASTM C 150, 54000-psi compressive strength, and normal weight aggregate.

4. Anchor housekeeping pads to slab using #3 rebar bent in "L" or "Z" shape 12 inch on center on each side of slab.

PART 3 – EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Seal space outside of sleeves with grout for penetrations of concrete and masonry

Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- G. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- H. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

- J. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

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

END SECTION 260500

SECTION 26 05 19

LOW VOLTAGE POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY:

- A. This section includes wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.
- C. Conform to applicable code regulations regarding toxicity of combustion products of insulating materials.

1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on electrical wires, cables and connectors.

1.4 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver wire and cable properly packaged in factory- fabricated type containers, or wound on NEMA-specified type wire and cable reels.
- B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.
- C. Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following (for each type of wire, cable, and connector):

- 1. Wire and Cable:
 - a. American Insulated Wire
 - b. Alcan
 - c. Belden Div; Cooper Industries.
 - d. Cerro

- e. Encore
- f. General Cable Corporation.
- g. Hitemp Wires, Inc.
- h. Southwire Company
- i. Okonite
- j. Equilivant manufacturer

2. Connectors:

- a. O-Z/Gedney Co.
- b. AMP, Inc.
- c. Burndy Corporation.
- d. Ideal Industries, Inc.
- e. 3M Company
- f. Thomas and Betts Corp.
- g. Equilivant manufacturer

2.2 WIRES AND CABLES:

- A. General: Provide wire and cable suitable for the temperature, conditions, and location where installed.
- B. Conductors: Provide solid conductors for power, control, and lighting circuits 10 AWG and smaller. Provide stranded conductors for 8 AWG and larger.

Conductors: Provide stranded conductors for all power, control, and lighting circuits.

- C. Conductor Material: Provide copper for all wires and cables.

1. Portable Cord:

- a. Type SO: Sizes 14 AWG through 2 AWG, copper conductors with 600 volt thermoset insulation 0.1 resistant insulation.
- b. Type G-GC: Sizes 1 AWG through 500 KCMIL, copper conductors with 600/2000 volt, 90 degreesC, ethylene-propylene insulation.

- 2. Cables: Provide the following types of cables in NEC approved locations and applications where permitted by the contract documents. Cables shall be U.L. listed and approved by the local building authority. All cables shall contain a green insulated equipment ground conductor of the same size as the neutral conductor.

2.3 CONNECTORS:

- A. Description: Provide UL-type factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperatures equal to or greater than those of the wires upon which used.
- B. Provide 2-hole compression lugs for all power feeder, neutral, and grounding connections. (Including phase, neutral and grounding conductors.
- C. Provide connectors that are designed to accept stranded conductors where stranded conductors are used.

PART 3 EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE:

- A. Building Wire: Install all building wire in raceway regardless of location.
- B. Portable Cord: Use for flexible pendant leads to luminaires, outlets, and equipment where indicated and in compliance with codes.

3.2 INSTALLATION OF WIRES AND CABLES:

- A. General: Install electrical cables, wires and connectors in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate wire/cable installation work, including electrical raceway and equipment connection work, with other work.
- C. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.
- D. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway. Do not use rope hitches for pulling attachment to wire or cable.
- E. Keep conductor splices to minimum. Splice only in accessible junction boxes. No splices are allowed in feeder, control or fire alarm wiring. Connect unspliced wire to numbered terminal strips at each end.
- F. Install splices and taps which possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- G. Use splice and tap connectors which are compatible with conductor material.
- H. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A for copper and 486B for aluminum.
- I. Support cables above accessible ceilings, do not rest on ceiling tiles. Use spring clips and hanger rods independent from the ceiling suspension system to support cables from structure.
- J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled to individual circuits. Make terminations so there is no bare conductor at the terminal.
- K. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated screw on type spring wire connectors with plastic caps, push on type are not acceptable.
- L. Use copper compression connectors for copper wire splices and taps, 1/0 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor.
- M. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- N. Thoroughly tape the ends of spare conductors in boxes and cabinets.

- O. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.
- P. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to individual ground terminal of devices.
- Q. Branch circuits whose length from panel to first outlet exceeds 100 feet for 120 volt circuits or 175 feet for 277 volt circuit shall be #10 or larger, as required to comply with the National Electrical Code.
- R. Parallel conductors shall be cut to the same length.
- S. All splices in control panels, terminal junction boxes, low voltage control circuits, fire alarm, etc., conductors shall be on numbered terminal strip.
- T. Where conduit is not required, plenum rated cable shall be provided in ceiling, floor or other air plenum spaces.
- U. Provide wire training, lacing, labeling, and terminal blocks as required in panelboards and all control cabinets including, but not limited to, lighting, transfer switch, fire alarm, and security cabinets. All wiring shall be installed neat and be labeled to match wiring diagrams, control devices, etc.
 - 1. Make temporary connections to panelboard devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.
- V. Color coding of switchlegs, travellers, etc. shall be different and distinct from phase and neutral conductors. Where systems utilize two (2) different voltages, the color coding of switchlegs, travelers, etc. shall be different and distinct for each voltage system.

3.3 FIELD QUALITY CONTROL:

- A. Test installed wires and cables with 1000 VDC megohm meter to determine insulation resistance levels to ensure requirements are fulfilled. Test shall be made on all feeders regardless of size and on all branch circuits with No. 4 AWG and larger conductors. The megger values obtained shall be compared to the minimum values listed in NETA. All phase conductors and cables shall be meggered after installation, and prior to termination. Submit test report.
- B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.
- C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.4 COLOR CODING SCHEDULE:

- A. Color code secondary service, feeder, and branch circuit conductors as follows:

<u>120/208 Volts</u>	<u>Phase</u>	<u>277/480 Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

- B. Conductors shall be solid color for entire length.
- C. If solid color conductor insulation is not available and specific acceptance is given by the engineer for use of black conductor insulation, provide the following:
 - 1. Conductors 6 AWG and smaller shall be solid color for the entire length.
 - 2. Conductors 4 AWG and larger shall have either solid color insulation as specified above for the entire length or be black with color coding at each termination and in each box or enclosure. For a distance of 6 inches use half-lapped $\frac{3}{4}$ inch plastic tape in the above specified color. Do not cover cable identification markings. Adjust tape locations to prevent covering of markings.

END OF SECTION 260519

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY:

- A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.2 QUALITY ASSURANCE:

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
- B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.
- C. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS:

- A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
- B. Conductor Materials: Copper.

2.2 WIRE AND CABLE CONDUCTORS:

- A. General: Comply with Division 26 Section on Wires and Cables. Conform to NEC, except as otherwise indicated, for conductor properties, including stranding.
- B. Equipment Grounding Conductor: Green insulated.
- C. Grounding Electrode Conductor: Stranded cable.
- D. Bare Copper Conductors: Conform to the following:
 - 1. Solid Conductors: ASTM B-3.
 - 2. Assembly of Stranded Conductors: ASTM B-8.
 - 3. Tinned Conductors: ASTM B-33.

2.3 MISCELLANEOUS CONDUCTORS:

- A. Ground Bus: Bare annealed copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.
- C. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.4 CONNECTOR PRODUCTS:

- A. General: Listed and labeled as grounding connectors for the materials used.
- B. Pressure Connectors: High-conductivity-plated units.
- C. Bolted Clamps: Heavy-duty units listed for the application.
- D. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

PART 3 EXECUTION

3.1 APPLICATION:

- A. Equipment Grounding Conductor Application: Comply with NEC for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
 - 1. Install separate insulated equipment grounding conductors with circuit conductors for the following in addition to those locations where required by Code:
 - a. Feeders and branch circuits.
 - b. Provide individual grounding and neutral conductors for each isolated ground receptacle. When individual or groups of isolated ground receptacles are on dedicated circuits, individual ground and neutral conductors for each circuit is acceptable.
 - 2. Busway Circuits: Install separate insulated equipment ground conductor from the ground bus in the switchgear, switchboard, or distribution panel to the equipment ground bar terminal on the busway.
 - 3. Nonmetallic Raceways: Install an insulated equipment ground conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- B. All systems shall be grounded in accordance with the NEC.

3.2 INSTALLATION:

- A. General: Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

3.3 CONNECTIONS:

- A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
 - 2. Make connections with clean bare metal at points of contact.
 - 3. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
- B. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors. Terminate each conductor on an individual ground lug terminal.
- C. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A.
- D. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.
- E. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

3.4 CLEANING AND ADJUSTING:

- A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Restore vegetation and disturbed paving to original condition.

END OF SECTION 260526

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY:

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 SUBMITTALS:

- A. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- B. Shop drawings indicating details of fabricated products and materials.
- C. Engineered Design consisting of details and engineering analysis for supports for the following items:
 - 1. Suspended transformers
 - 2. Cable trays
 - 3. Trapeze hangers for multiple conduit runs.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit
 - b. B-Line Systems, Inc.
 - c. Unistrut Diversified Products
 - d. Equilivant manufacturer
 - 2. Conduit Sealing Bushings:
 - a. O-Z/Gedney
 - b. Cooper Industries, Inc.
 - c. Killark Electric Mfg. Co.
 - d. Madison Equipment Co.
 - e. Raco, Inc.
 - f. Spring City Electrical Mfg. Co.
 - g. Thomas & Betts Corp.
 - h. Equilivant manufacturer

2.2 COATINGS:

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES:

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
 - 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 12-gage steel channels, with 9/16 inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.
- F. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
 - 1. One-Hole Conduit Straps: For supporting ¾ inch and smaller rigid metal conduit; galvanized steel.
 - 2. Two-Hole Conduit Straps: For supporting 1 inch and larger rigid metal conduit, galvanized steel; ¾ inch strap width; and 2-1/8 inch between center of screw holes.

2.4 FABRICATED SUPPORTING DEVICES:

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - 1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 2. EMT, IMC, or Rigid Conduit.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Junction Box Supports: Comply with the NEC and the following requirement:
 - 1. Use ¼" all-thread rod from structure to support junction boxes.
- D. Raceway Supports: Comply with the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Use #9 ceiling wire to support individual conduits up to ¾ inch with spring steel fasteners. Use of ceiling support wires is unacceptable.
 - 5. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8 inch diameter or larger threaded steel rods for support.
 - 6. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼ inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing. For hanger rods supporting 1-1/2 inch or larger conduits provide 3/8 inch minimum threaded steel rods with pipe hangers.
 - 7. Space supports for raceways in accordance with NEC. When there are 4 or more 2 inch conduits in a trapeze, supports shall be spaced 5 feet O.C.
 - 8. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 - 9. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.
- E. Conductor Supports: Comply with the NEC and the following requirements:
 - 1. Support individual conductors or cables by separate clamps with rubber or plastic grommet, fasten using a non-metallic bolt and nut, and secure clamps to unistrut supports anchored to structure (multiple clamps may be secured to a single unistrut support). Individual conductors or

cables may be served utilizing a vinyl or fiberglass clamp which shall be anchored to the structure.

2. Space supports as follows:

- a. Horizontal conductors not more than 3 feet o.c.
- b. Vertical conductors not more than 5 feet o.c.

3. Install simultaneously with installation of conductors.

- F. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- G. In overhead spaces, support metal boxes directly from the building structure via 1/4" minimum all-thread or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box. Supporting metal boxes utilizing ceiling type wire is not acceptable.
- H. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for cable installations as required. Where sleeves through floors are installed, extend above finish floor. For sleeves through fire rated-wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and cables in accordance with "Fire Resistant Joint Sealers" requirement of Division 7 Section "Joint Sealers." See Architectural plans for location and extent of fire rated assemblies.
- I. Conduit Seals: Install seals for conduit penetrations of exterior walls below grade. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- J. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws, where authorized by the Owner and structural engineer. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

3.2 PERSONNEL PROTECTION:

- A. Where U-channel systems, angles, brackets or other standard structural metal shapes are readily accessible and exposed to personnel, provide plastic or rubber end caps.
- B. Where threaded rod supports are readily accessible and exposed to personnel, provide plastic or rubber end caps.

END OF SECTION 260529

SECTION 26 05 33

RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY:

- A. Extent of raceway work is indicated by drawings and schedules. Provide complete conduit systems for all conductors unless otherwise specified.
- B. Types of raceways specified in this section include the following:
 - 1. Electrical metallic tubing (EMT).
 - 2. Flexible metal conduit.
 - 3. Intermediate metal conduit (IMC).
 - 4. Liquid-tight flexible metal conduit.
 - 5. Non-metallic Conduit and Ducts.
 - 6. Rigid metal conduit (RGC).

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.

1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Submit dimensioned drawings of surface metal raceway systems showing layout of raceways and fittings, spatial relationships to associated equipment, and adjoining raceways, if any. Show connections to electrical power panels and feeders.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Rigid Metal Conduit:
 - a. Allied
 - b. Wheatland
 - c. Triangle
 - d. Western Tube & Conduit
 - e. Equilivant manufacturer
 - 2. Intermediate Metal Conduit (IMC):
 - a. Allied

- b. Triangle
 - c. Western Tube & Conduit
 - d. Equilivant manufacturer
3. EMT Conduit:
- a. Allied
 - b. Republic
 - c. Triangle
 - d. LTV
 - e. Western Tube & Conduit
 - f. Equilivant manufacturer
4. Steel Fittings:
- a. O/Z Gedney
 - b. Raco
 - c. Appleton
 - d. EPT
 - e. Midwest
 - f. Picoma
 - g. Steel City
 - h. Equilivant manufacturer
5. Conduit Bodies:
- a. O/Z Gedney
 - b. Killark
 - c. Regal
 - d. Appleton
 - e. Crouse Hinds
 - f. Equilivant manufacturer

2.2 METAL CONDUIT AND TUBING:

A. Rigid Galvanized Steel Conduit (RGC):

- 1. Conduit: Rigid steel, zinc-coated inside and outside, threaded ends.
- 2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.

B. Intermediate Metal Conduit (IMC):

- 1. Conduit: Rigid intermediate grade galvanized inside and outside, threaded ends.
- 2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.

C. Electrical Metallic Tubing (EMT):

- 1. Conduit: Galvanized steel tubing.
Fittings: Steel compression fittings for rain-tight and concrete-tight applications. Steel set-screw for all other connections. Set-screw quick fit type for 2-1/2 inches and larger may be used. Bushings shall be threaded and have nylon insulated throat or nylon bushing.

D. Liquid-Tight Flexible Metal Conduit:

- 1. Conduit: Continuous spiral wound, interlocked zinc-coated steel with polyvinyl chloride (PVC) jacket, approved for grounding.

2. Fittings: Cadmium plated malleable iron. Straight and angle connectors shall be the same as used with flexible metal conduit but shall be provided with a compression type steel ferrule and neoprene gasket sealing rings.

2.3 CONDUIT BODIES:

- A. General: Types, shapes and sizes, as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use malleable iron conduit bodies. Use bodies with threaded hubs for threaded raceways and in hazardous locations.
- C. Nonmetallic Conduit: Use nonmetallic conduit bodies.

2.4 CONDUIT SIZES:

- A. Conduit sizes shall be as shown on the drawings. If the conduit size is not given on the drawings, the conduit shall be sized in accordance with NEC based on the number of conductors enclosed plus a parity sized equipment ground conductor and be subject to the following minimum sizes:
 1. Rigid, Intermediate, and EMT Conduit: 3/4 inch for all runs except lighting switch legs, 277 volt lighting branch circuits, temperature control and fire alarm which may be 1/2inch.
 2. Flexible and Liquid-Tight Flexible Conduit: 1/2inch for all runs.
 3. Combining multiple home runs into a single conduit will not be permitted.

2.5 RACEWAY SEALING COMPOUND:

- A. Nonhardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 deg F (1 deg C), withstands temperature of 300 deg F (149 deg C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials and the common metals.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 CONDUIT SCHEDULE:

- A. Raceways in locations subject to mechanical injury: Rigid steel galvanized conduit. Locations subject to mechanical injury include, but are not limited to, the following:
 1. Exposed conduits outdoors up to 8' AFG.
 2. Exposed conduits in bus parking areas and high/medium bay locations up to 15 feet above finished floor.
 3. Exposed conduits up to 8'.
 4. Exposed service entrance feeders.
 5. Class 1 Div 2 locations
- B. Equipment charger connections: PVC jacketed liquid-tight flexible metallic conduit with liquid tight connectors.

- C. Raceways in all other areas shall be electrical metallic tubing unless otherwise noted.
- D. Use flexible metal conduit inside movable partition wireways, from junction boxes to devices and between devices in casework, from outlet boxes to recessed luminaires, and for "fishing" of existing walls.
- E. Rework or extensions of existing conduit shall include the use of similar materials to the existing conduit type unless otherwise noted.

3.3 INSTALLATION OF CONDUITS:

- A. General: Install electrical raceways in accordance with manufacturer's written installation instruction, applicable requirements of NEC, and as follows:
 - 1. Conceal all conduit unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
 - 2. Elevation of Raceway:
 - a. Where horizontal raceway is installed near water and steam piping, route raceway above piping and as close to structure as possible and practical.
 - b. Route raceway as close to structure as possible.
 - 3. Complete installation of electrical raceways before starting installation of conductors within raceways.
 - 4. Provide supports for raceways as specified elsewhere in Division 16.
 - 5. Prevent foreign matter from entering raceways by using temporary closure protection.
 - 6. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
 - 7. Use raceway fittings that are types compatible with the associated raceway and suitable for the use and location. Install expansion fittings across all structural construction joints and expansion/deflection couplings across all structural expansion joints.
 - 8. Run raceways parallel and perpendicular to building elements and other equipment with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
 - 9. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
 - 10. Install vertical feeder conduits in exterior walls, core walls, or chase spaces. Do not install in interior wall partition areas.
 - 11. Run exposed and parallel raceways together. Make bends in parallel runs from the same center line so that the bends are parallel. Factory elbows may be used only where they can be installed parallel. In other cases provide field bends for parallel raceways.
 - 12. Make raceway joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where

terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Joints in non-metallic conduits shall be made with solvent cement in strict accordance with manufacturer's recommendations.

13. Tighten set screws of threadless fittings with suitable tool.
14. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. RGC and IMC shall be secured with double locknuts and an insulated metallic bushing. EMT shall be secured with one locknut and shall have nylon insulated throats or threaded nylon bushings from 1/2" to 1". 1-1/4" and above shall be metal with nylon insulated throats. Use grounding type bushings for feeder conduits at switchboards, panelboards, pull boxes, transformers, motor control centers, VFD's, etc.
15. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
16. Provide nylon pull string with printed footage indicators having not less than 200 pounds tensile strength. Leave not less than 12 inches of slack at each end of the pull string. Identify with tags at each end the origin and destination of each empty conduit and indicate same on all empty or spare conduits on the as-built drawings.
17. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-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 and elsewhere as indicated: Where required by the NEC.
18. Install raceway/duct sealing compound inside of all underground stub into a building through a foundation wall or through a slab on grade floor.
19. Flexible Connections: Use short length (maximum of 6 feet) of flexible conduit for recessed and semi-recessed luminaires, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate ground conductor across flexible connections.
20. Where conduits are to be installed through structural framing members, the Contractor shall provide sleeves. The Architect/Engineer's written approval must be obtained prior to cutting, notching or drilling of structural framing members.
21. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.
22. Use of running threads for rigid or intermediate metallic conduit are not permitted. When threaded couplings cannot be used, provide 3 piece union or solid coupling.
23. Route conduit through roof openings for piping and ductwork where possible; otherwise, rout through jack with pitch pocket.
24. Conduits shall not cross pipe shafts or ventilation duct openings. Where conduits must penetrate air-tight spaces or plenums, seal around the conduit with a mastic acceptable to the Architect/Engineer.
25. Install an insulated ground conductor in all conduits.

26. Where individual conduits penetrate existing fire-rated walls and floors, pack void around conduit with fire rated insulation and seal opening around conduit with UL listed form silicone elastomer compound. Where conduits penetrate exterior walls, new floors, or roof, provide pipe sleeve one size larger than conduit, pack void around conduit with fire rated insulation, and seal opening around conduit with UL listed foam silicone elastomer compound.
 27. Wipe plastic conduit clean and dry before joining. Apply full even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.
- B. Install labeling as required in Division 26 section - "Electrical Identification".
- 3.4 ADJUSTING AND CLEANING:
- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt and construction debris. END OF SECTION 260533

SECTION 260534

CABINETS, BOXES, AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY:

- A. This section includes cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other sections. Types of products specified in this section include:
 - 1. Outlet and device boxes.
 - 2. Pull and junction boxes.
 - 3. Cabinets.
 - 4. Hinged door enclosures.
 - 5. Boxes and fittings for hazardous locations.
- B. Conduit-body-type electrical enclosures and wiring fittings are specified in the Division 26 Section on Raceways.

1.2 DEFINITIONS:

- A. Cabinets: An enclosure designed either for surface or for flush mounting and having a frame, or trim in which a door or doors may be mounted.
- B. Device Box: An outlet box designed to house a receptacle device or a wiring box designed to house a switch.
- C. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.
- D. Hinged Door Enclosure: An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box.
- E. Outlet Box: A wiring enclosure where current is taken from a wiring system to supply utilization equipment.
- F. Wiring Box: An enclosure designed to provide access to wiring systems or for the mounting of indicating devices or of switches for controlling electrical circuits.

1.3 SUBMITTALS:

- A. Submit product data for cabinets and enclosures with classification higher than NEMA 1.
- B. Shop drawings for floor boxes and boxes, enclosures and cabinets that are to be shop fabricated, (non-stock items). For shop fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cabinets:
 - a. Hoffman Engineering Co.
 - b. Erickson Electrical Equipment Co.
 - c. Electric Panelboard, Inc.
 - d. Parker Electrical Mfg. Co.
 - e. Spring City Electrical Mfg. Co.
 - f. Square D Co.
 - g. Circle AW

2. Boxes and Fittings for Hazardous Locations:
 - a. OZ/Gedney.
 - b. Cooper Industries, Inc.
 - c. Killark Electric Mfg. Co.
 - d. Adalet-PLM.
 - e. Robroy Industries, Inc.
 - f. Spring City Electrical Mfg. Co.
 - g. Appleton

2.2 CABINETS, BOXES, AND FITTINGS, GENERAL:

- A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

2.3 MATERIALS AND FINISHES:

- A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.
- B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
- C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.
- D. Cast Metal for Boxes, Enclosures, and Covers; Copper-free aluminum except as otherwise specified.
- E. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.
- F. Painted Interior Finish: Where indicated, white baked enamel. Emergency system cabinets and boxes shall be red.
- G. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.

2.4 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES:

- A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application.
- B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories

suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.

- C. Cast-Aluminum Boxes: Copper free aluminum threaded raceway entries, and features and accessories suitable for each location including mounting ears, threaded screw holes for devices and closure plugs.
- D. Malleable or Cast-Iron Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.
- E. Malleable or Cast-Iron Floor Boxes: Fully adjustable, waterproof, with threaded raceway entrances, adjusting rings, gaskets, and brass floor plates. Where indicated, provide multi-section boxes with individual hinged section covers. Provide for power, data, and communication outlets as indicated on the drawings.

2.5 PULL AND JUNCTION BOXES:

- A. General: Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
- B. Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing.
- C. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.
- D. Stainless-Steel Boxes: Fabricate of stainless steel conforming to Type 302 of ASTM A 167, "Specification for Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip." Where necessary to provide a rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.
- E. Cast-Aluminum Boxes: Molded of copper free aluminum, with gasketed cover and integral threaded conduit entrances.
- F. Malleable or Cast-Iron Boxes: Molded of iron alloy with gasketed cover and integral threaded conduit entrances.
- G. Boxes Approved for Classified Locations: Cast metal boxes conforming to UL 886, "Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations," listed and labeled for use in the specific location classification, and with the specific hazardous material encountered. Conduit entrances shall be integral threaded type.

2.6 CABINETS:

- A. Comply with UL 50, "Electrical Cabinets and Boxes."
- B. Construction: Sheet steel, NEMA 1 class except as otherwise indicated. Cabinet shall consist of a box and a front consisting of a one piece frame and a hinged door. Arrange door to close against a rabbet placed all around the inside edge of the frame, with a uniformly close fit between door and frame. Provide concealed fasteners, not over 24 inches apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24 inches apart and not over 6 inches from

top and bottom of door. For flush cabinets, make the front approximately 3/4" larger than the box all around. For surface mounted cabinets make front same height and width as box.

- C. Doors: Double doors for cabinets wider than 24 inches. Telephone cabinets wider than 48 inches may have sliding or removable doors.
- D. Locks: Combination spring catch and key lock, with all locks for cabinets of the same system keyed alike. Locks may be omitted on signal, power, and lighting cabinets located within wire closets and mechanical-electrical rooms. Locks shall be of a type to permit doors to latch closed without locking.

2.7 STEEL ENCLOSURES WITH HINGED DOORS:

- A. Comply with UL 50, "Cabinets and Enclosures" and NEMA ICS 6, "Enclosures for Industrial Controls and Systems."
- B. Construction: Sheet steel, 16 gage, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface mounting.
- C. Doors: Hinged directly to cabinet and removable, with approximately 3/4 inch flange around all edges, shaped to cover edge of box. Provide handle operated, key locking latch. Individual door width shall be no greater than 24 inches. Provide multiple doors where required.
- D. Mounting Panel: Provide painted removable internal mounting panel for component installation.
- E. Enclosure: NEMA 1 except as indicated. Where door gasketing is required, provide neoprene gasket attached with oil-resistant adhesive, and held in place with steel retaining strips. For all enclosures of class higher than NEMA 1, use hubbed raceway entrances.

2.8 CAST METAL ENCLOSURES WITH HINGED DOORS:

- A. Copper free aluminum with bolted, hinged doors. Where used at hazardous (classified) locations, enclosures shall conform to UL and shall be listed and labeled for the classification of hazard involved.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL:

- A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with Division 26 Section on Supporting Devices.
- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
- E. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 APPLICATIONS:

- A. Cabinets: Flush mounted, NEMA enclosure type 1 except as otherwise indicated.

- B. Hinged Door Enclosures Indoor: NEMA type 1 enclosure except as indicated.
- C. Hinged Door Enclosures Outdoors: NEMA Type 4. Install drip hood, factory tailored to individual units.
- D. Hinged Door Enclosures in Corrosive Locations: NEMA type 4X nonmetallic enclosure.
- E. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
 - 1. Interior Dry Locations: NEMA Type 1, sheet steel.
 - 2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.
 - 3. Wet Locations: NEMA Type 4 enclosures.
 - 4. Corrosive Locations: NEMA Type 4X enclosures.
 - 5. Hazardous (Classified) Locations: NEMA type listed and labeled for the location and class of hazard indicated.
- F. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.
- G. Floor Boxes: In slabs on grade and wet locations use NEMA type 4 boxes. At other locations in slabs, use concrete-tight NEMA 1 boxes.

3.3 INSTALLATION OF OUTLET BOXES:

- A. Outlets at Windows and Doors: Locate close to window trim. For outlets indicated above doors center outlets above the door opening except as otherwise indicated.
- B. Column and Pilaster Locations: Locate outlet boxes for switches and receptacles on columns or pilasters so the centers of the columns are clear for future installation of partitions.
- C. Locations in Special Finish Materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides. Install such boxes without plaster rings. Saw cut all recesses for outlet boxes in exposed masonry walls.
- D. Gasketed Boxes: At the following locations use malleable or cast metal, threaded hub type boxes with gasketed weatherproof covers:
 - 1. Exterior locations.
 - 2. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations).
 - 3. Where exposed to moisture laden atmosphere.
 - 4. At food preparation equipment within four ft. of steam connections.
 - 5. Where indicated.
- E. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles vertically, except above counter receptacles to be mounted horizontally. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for

switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side. Provide far side box supports, for electrical switch boxes installed on metal studs and provide stud to stud support for electrical receptacle boxes installed on metal studs.

- F. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4 inches square by 1-1/2 inches deep, minimum.
- G. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.
- H. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.
- I. Concrete Boxes: Use extra deep boxes to permit side conduit entrance without interfering with reinforcing, but do not use such boxes with over 6 inch depth.
- J. Floor Boxes: Install in concrete floor slabs so they are completely enveloped in concrete except for the top. Where normal slab thickness will not envelop box as specified above, provide increased thickness of the slab. Provide each compartment of each floor box with grounding terminal consisting of a washer-in-head machine screw, not smaller than no. 10-32, screwed into a tapped hole in the box. Adjust covers of floor boxes flush with finished floor.
- K. Existing Outlet Boxes: Where extension rings are required to be installed, drill new mounting holes in the rings to align with the mounting holes on the existing boxes where existing holes are not aligned.
- L. Back to back outlet boxes are not permitted. Separate boxes a minimum of 6 inches in standard walls and 24 inches in acoustical walls.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES:

- A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8 inches square by 4 inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed the following:

Size of Largest Conductors in <u>Box</u>	Maximum no. of Conductors in <u>Box</u>
No. 4/0 AWG	30
250 MCM	20
500 MCM	15
Over 500 MCM	10

- B. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 inches inside boxes.
- C. Mount pull boxes in inaccessible ceilings with the covers flush with the finished ceiling.
- D. Size: Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.5 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES:

- A. Mount with fronts straight and plumb.
 - B. Install with tops 78 inches above floor.
 - C. Set cabinets in finished spaces flush with walls.
- 3.6 GROUNDING:
- A. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.
- 3.7 CLEANING AND FINISH REPAIR:
- A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
 - B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.
 - C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION 260534

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY:

- A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
 - 1. Identification labeling for raceways, cables, and conductors.
 - 2. Operational instruction signs.
 - 3. Warning and caution signs.
 - 4. Equipment labels and signs.

1.2 QUALITY ASSURANCE:

- A. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Ideal Industries, Inc.
 - 2. LEM Products, Inc.
 - 3. Markal Corp.
 - 4. Panduit Corp.
 - 5. W.H.Brady, Co.
 - 6. 3M Company
 - 7. Equilivant manufacturer

2.2 ELECTRICAL IDENTIFICATION PRODUCTS:

- A. Provide colored Adhesive Marking Tape for banding Wires and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width. Make each color band completely encircling cables, at penetrations of walls and floors, at each junction box and at 20-foot maximum intervals in straight runs.
- B. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Engraved legend in white letters on black face for normal and white letters on red face for emergency, black letters on yellow face for UPS and punched for mechanical fasteners. Where required for ground connections, provide engraved legend in white letters on green face.
- C. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

- D. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50 lb minimum tensile strength, and suitable for a temperature range from minus 50 degrees F to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- D. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system voltage and identity of contained circuits on outside of box cover. Color code shall be same as conduits for pressure sensitive labels. Use self adhesive marking tape labels at exposed locations and indelible black marker at concealed boxes. All fire alarm boxes shall have covers painted red. All temperature control boxes shall have covers painted blue.
- E. Circuit Identification: Tag or label conductors as follows:
 - 1. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
 - 2. Multiple Circuits: Where multiple branch circuits, control wiring or communications/signal conductors are terminated or spliced in a box or enclosure, label each conductor or cable with circuit number. For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 - 3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- F. Apply warning, caution and instruction signs and stencils as follows:
 - 1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
- G. Install equipment/system circuit/device identification as follows:
 - 1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Text shall match terminology and numbering of the Contract

Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.

- a. Panelboards, electrical cabinets and enclosures.
- H. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.
- I. For panelboards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.
- J. For devices and switches, provide tape label with panel and circuit information.
- K. Install labels at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

END OF SECTION 260553

SECTION 26 05 83

EQUIPMENT CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY:

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Applications of electrical power connections specified in this section include the following:
 - 1. To equipment requiring electrical connection.
 - 2. Other connections as shown.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS:

- A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, disconnect, starter, contactor, relays, etc., and other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing and Fittings:
 - 1. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Provide products complying with Division-26 section on Raceways.
- C. Wires, Cables, and Connectors:
 - 1. General: Provide wires, cables, and connectors complying with Division-26 section on Wires and Cables.
 - 2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes, ratings, and material of wires/cables which are supplying electrical power.

3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.
5. Cord and Plug Connected Equipment: Where indicated, contractors shall provide a length of SO cord complete with a straight blade or twist-lock receptacle for connection of equipment. Cord and plug rating shall be suitable for the connected equipment load and rating of the branch circuit overcurrent protective device. Plug shall match receptacle configuration included on the plans and cord length shall be as required. Contractor shall connect cord to equipment.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. Furnish, set in place, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, plumbing and fire protection, elevator, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.
- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Maintain existing electrical service and feeders to equipment serving occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.
- E. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- F. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

- G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
 - H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.
 - I. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
 - J. Provide suitable strain relief clamps for cord connection to outlet boxes and equipment connection boxes.
 - K. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
 - L. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated or per manufacturer's instructions.
 - M. Provide circuit and motor disconnect switches as indicated and where required by Code. Comply with switch manufacturers printed installation instructions. Install within sight of motors.
 - N. All splices in control panels, terminal junction boxes, low voltage control circuits and fire alarm conductors shall be on numbered terminal strip.
 - O. Each branch circuit serving dedicated, isolated or emergency receptacles, multi-outlet assemblies or equipment connections shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit shall only be permitted where specifically noted.
- 3.3 FIELD QUALITY CONTROL:
- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION 260583