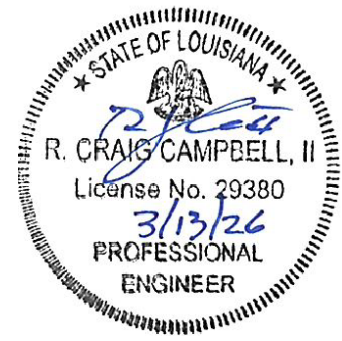


**SECTION 23 00 10**  
**MECHANICAL GENERAL PROVISIONS**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. Furnish all labor and material necessary to provide and install the complete mechanical portion of this Contract as called for herein and on accompanying drawings. Parts of the mechanical division may be bid separately or in combination, at the Contractor's option; however, it shall be the responsibility of the Contractor to assure himself that all items covered in the mechanical Division have been included if he chooses to accept separate bids.
- B. It is the intent of this specification that all materials with temperatures below ambient conditions or conveying any fluid/gas at temperatures below 70 deg. F be insulated to completely eliminate the potential for condensation. Unless specified elsewhere in these specifications, for materials that do not require and requiring occasional access, use 2" thick closed cell rubberized insulation with re-sealable fabric joints (hook and loop type).
- C. Contractor shall refer to the Architectural and Structural drawings and install equipment, piping, etc. to meet building and space requirements. No equipment shall be bid on or submitted for approval if it will not fit in the space provided.
- D. It is the intention of these specifications that all mechanical systems shall be furnished complete with all necessary valves, controls, insulation, piping devices, equipment, etc. necessary to provide a satisfactory installation that is complete and in good working order.
- E. Contractor shall visit the site and acquaint himself thoroughly with all existing facilities and conditions which would affect his portion of the work. Failure to do so shall not relieve the Contractor from the responsibility of installing his work to meet the conditions.
- F. Contractor shall protect the entire system and all parts thereof from injury throughout the project and up to acceptance of the work. Failure to do so shall be sufficient cause for the Architect to reject any piece of equipment.
- G. Provide as work of this Division (unless clearly and specifically indicated as a requirement of the Division 26 contractor on the Division 26 drawings) the following:
  - 1. 120V power to all temperature control panels, unit controllers, field devices, etc. as required.
  - 2. Wiring of any remote start/stop switches, occupancy sensors, manual or automatic motor speed control devices, motorized damper actuators controlling Division 23 equipment.

**1.3 BIDDING REQUIREMENTS AND RESPONSIBILITIES**

- A. Prime bidder is responsible for all work, of all trades and sub-contractors bidding this project. It is the prime bidder's responsibility, prior to submitting a bid to ensure that sub-contractors coordinate all aspects of the work between trades, sub-contractors, etc. to the fullest extent possible.
- B. Prime bidder shall ensure that all sub-contractors, suppliers, equipment vendors, etc., obtain all necessary and pertinent contract document information pertaining to their work prior to the submission of a bid.
- C. Bidders of all or any portions of this section or division are required to review all contract documents including but not limited to Architectural drawings, Structural drawings, Mechanical drawings, Plumbing drawings, Electrical drawings, and Fire Alarm drawing section to coordinate requirements and responsibilities with and through prime bidder.

- D. Bidders of all or any portions of this section or division, by furnishing a bid on a portion of the prime contract are indicating that they have received all contract documents and coordinated services provided under their portion of the work with the prime bidder; they are indicating that they have expressed any pertinent questions (which would result from a detailed, thorough review of the entire set of contract documents) to the prime bidder in accordance with Division 01 requirements, prior to bidding.
- E. All timely, pertinent, questions provided in writing prior to bids, in accordance with Division 01 requirements, will be clarified, defined, or otherwise explained in written addendum and / or addendums prior to bids, in accordance in Division 01 requirements.
- F. It is not the intention of these contract documents to leave any issue relating to coordination between trades or sub-contractors vaguely defined. The intention is to define all issues, coordination matters, equipment requirements, sizes, routing, etc. to the satisfaction of the prime bidder, prior to receipt of bids.
- G. Bidders of all or any portions of this section or division, by virtue of the submission of a bid to the prime bidder, are indicating that they have reviewed the entire set of contract documents with due diligence and regard for the Owner's desire for a comprehensive and complete bid proposal; that they have expressed all concerns or questions requiring clarification on matters of coordination between trades and/or sub-contractors; that they have expressed any such concerns or questions in writing in accordance with Division 01 requirements.
- H. Prime bidders, by submission of a comprehensive bid on the project are indicating that the subcontractors selected in their bid have complied with all Division 01 requirements, that they have indicated in writing, prior to bidding, all questions or concerns requiring clarification and/or explanation and have documented any and all specific exclusions involving work that would generally be considered to be work of their trade. The prime bidder shall coordinate all work so that anything excluded by the bidder of all or any portions of this section or division, have been addressed prior to bids in one of the following manners:
  - 1. The work has been confirmed, by the prime bidder, to be work of another trade or subcontractor (whose proposal is also being accepted).
    - a. Clarification of the matter has been made through the prime design professional via written addendum and is clearly and mutually understood by the prime bidder and the party raising the issue/question, or seeking clarification.
    - b. The work has been accepted as the responsibility of the Contractor directly.

#### 1.4 POST-BID VALUE ENGINEERING (V/E):

- A. Value Engineering (V/E) defined: For purposes of Division 23 Specifications, in accordance with all Division 01 Requirements and all Terms and Conditions of proposed contract between Owner and Contractor, Value Engineering (V/E) shall be defined as a "post bid" process, whereby the apparent low bidder (having submitted a proposal in strict accordance with Project Contract Documents, that exceeds the Owner's available funds for construction [AFC] for this specified project offers proposed changes ("Value Engineering") to the work. This proposed value engineering may alter or adjust aforementioned contract document requirements in exchange for financial and/or other consideration (in response to a specific request by the Owner/Owner's Representative).
- B. Value Engineering may not be considered, prior to scheduled receipt and review of Bid Proposals by the Owner and an official written request from the Owner/Owner's Representative expressing the Owner's desire to consider value engineering items.
- C. While it may be in the project Owner's interest to consider the first cost money saving that may be generated via alternatives and options generated via participation in Value Engineering, Division 23 contractor shall realize that substantive offers of Value Engineering (V/E), if accepted by the Owner, constitute a design-build agreement (offer and acceptance) with the owner, and drastically change the design concept of the project, as developed by the Professional of Record identified on the Contract Documents.
- D. Should Contractor offer, and the owner accept value engineering options that alter aspects of the system design, equipment, performance and/or performance verification or monitoring of respective systems, Contractor shall provide duly licensed professional engineering consultants working on behalf of the Contractor (including sub-contractors and equipment vendors/manufacturers) to review, approve and take professional responsibility for performance and suitability of V/E hybrid systems, materials or operational changes related to respective V/E items. The Contractor's licensed professional engineering consultants and the Contractor assume any and all responsibility for the design and suitability in terms of performance, of hybrid systems installed, as Contractor's Professional of Record, absolving the original project Professional of Record (identified on the original Contract

Documents, released for the original project Bid/Negotiation) from responsibility for the V/E hybrid systems portion of the work.

- E. Division 23 Contractor, via the offer and acceptance of value engineering items on the project agrees to provide professional engineering design services and take full and complete responsibility for the hybrid design. Further, the Contractor's (V/E Items) professional of record (either employees, or independent consultants to the Contractor) through the offer and acceptance of V/E items, agree to indemnify and hold harmless the project owner, the owner's original A/E team (Professional of Record on behalf of the owner for the original Contract Documents) their heirs and assigns in regard to the V/E changes and their impact on the Division 23 systems altered, affected or modified, in whole or in part. The Professional of Record shown on the original Contract Documents in regard to the systems altered, adjusted, revised, modified or otherwise affected by the value engineering items implemented, shall be absolved of design responsibility as a result of implementation of V/E items, and their original use of Engineering Seals used for original Contract Documents, shall not apply.

#### 1.5 MATERIAL AND EQUIPMENT

- A. The term "provide" when used in the Contract Documents shall mean "furnish and install" and includes all items necessary for the proper execution and completion of the Work.
- B. Specific reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect expressed in writing is equal to that specified.
- C. Coordinate and properly relate all Work of this Division to building structure and work of all other trades.
- D. Visit premises and become thoroughly familiar with existing conditions; verify all dimensions in field. Advise Architect of any discrepancies prior to Bid Date in accordance with Division 00.
- E. Do not rough-in for any item or equipment furnished by others or noted "Not in Contract" (NIC), without first receiving rough-in information or determining rough-in requirements from physically examining the existing equipment, receiving specific cut sheet information from the Owner's representative, other trades and/or Architect. Rough-in services for "NIC" equipment as required, as the work progresses.
- F. Provide storage and protection for all equipment and materials in accordance with requirements of Division 00 and Division 01. Replace any equipment and materials damaged by improper handling, storage, or protection, at no additional cost to Owner.
- G. Keep premises clean in accordance with requirements of Division 00 and Division 01.

#### 1.6 SUBSTITUTIONS

- A. Substitutions are allowed under La. R.S. 38:2291 and La R.S. 38:2292. Any requests for prior approval (as provided for under La. R.S. 38:2295) including any re-submitted data, shall be received by the Architect/Engineer a minimum of fourteen (14) working days prior to bid date. The Contractor shall recognize that it may be necessary to submit certain requests for prior approval sooner than the final date listed in the Instructions to Bidders, depending upon the complexity and completeness of the submittal. If, in the opinion of the Architect/Engineer, there is neither sufficient time available nor adequate descriptive data attached to the submittal, the submittal will not be considered. Except as otherwise specified, materials and equipment shall be new and bear the approval label of the Underwriters Laboratories, Inc. for the type of installation required.
- B. Basis of design of systems is based on specific equipment for performance, size, shape, color, construction material, etc... If the use of other manufacturer's equipment, even though approved by Architect, involves additional cost due to space requirements, foundation requirements, increased mechanical or electrical services, the cost of such extra work shall be borne by the contractor. Even though a manufacturer's name appears in the Contract Documents as having acceptable equipment, his equipment shall be classified as being a substitute to the equipment originally designed for and named in the Contract Documents. Substitute equipment, materials, etc., will not be allowed to deviate from basis of design requirements.

- C. All requests for prior approval shall identify where proposed material matches or exceeds the performance of the equipment specified. In addition, such submittal shall also clearly identify all deficiencies compared to specified product. Submittal of general cut sheets will be returned rejected.

#### 1.7 DRAWINGS AND SPECIFICATIONS

- A. The specific intent of these Contract Documents is to provide the various systems, equipment, etc. to the Owner complete and in a thoroughly calibrated and functional condition.
- B. The Drawings shall not be construed as shop drawings. In the event of a possible interference with piping or equipment of another trade, items requiring set grade and elevations shall have precedence over other items. Should any major interference develop, immediately notify the Architect.
- C. In laying out Work, refer to Contract Documents at all times in order to avoid interference and undue delays in the progress of the Work.
- D. Furnish all plumbing fixtures (with required accessories) shown on either the plumbing drawings or the architectural drawings. Review Architectural casework elevations and identify fixtures indicated. Provide fixtures indicated. Rough-in for all fixtures as work progress. Verify plumbing fixtures required from review of Mechanical and Architectural drawings, prior to fixture shop drawing submittal.

#### 1.8 CODES AND REGULATIONS

- A. Work shall be in full accord with the most stringent interpretation of the State Sanitary Code, local ordinances, building codes, and other applicable national, local, and state regulations.
- B. Equipment shall conform to requirements and recommendations of the National Bureau of Fire Underwriters and National Fire Protection Association (NFPA).
- C. Items provided under this Division shall comply with the American National Standards Institute (ANSI) "Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People," ANSI A 117.1
- D. In the possible event of conflict between codes or regulations and Contract Documents, notify the Architect immediately. Codes and Standards represent minimum requirements. These specifications may exceed requirements in various codes and standards.

#### 1.9 FEES, PERMITS, AND TAXES

- A. Obtain and pay for permits required for the Work of this Division. Pay fees in connection therewith, including necessary inspection fees.
- B. Pay any and all taxes levied for Work of this Division, including municipal and/or state sales tax where applicable.

#### 1.10 MANUFACTURER'S DIRECTIONS

- A. Install and operate equipment and material in strict accord with manufacturer's installation and operating instructions. The manufacturer's instructions shall become part of the Contract Documents and shall supplement Drawings and Specifications.

#### 1.11 SUBMITTAL DATA

- A. Submit shop drawings, project data, and samples in accordance with requirements of Division 01.
- B. Shop drawings shall consist of published ratings or capacity data, detailed construction drawings for fabricated items, wiring and control diagrams, performance curves, installation instructions, manufacturer's installation drawings, and other pertinent data. Submit drawings showing revisions to equipment layouts due to use of alternate or substitute equipment.
- C. Where approved manufacturers and suppliers of equipment, materials, etc. are unable to fully comply with Contract Document requirements, specifically call such deviations to

attention of Architect on submittals. Type deviations on a separate sheet; underlined statements or notations on standard brochures, equipment fly sheets, etc. will not be accepted.

- D. Approval of submittals shall not relieve Contractor from furnishing required quantities and verifying dimensions. In addition, approval shall not waive original intent of Contract Documents.
- E. Failure to obtain written approval of equipment shall be considered sufficient grounds for rejection of said equipment regardless of the stage of completion of the project.

#### 1.12 PROJECT RECORD DOCUMENTS

- A. Keep Project Record Documents in accordance with requirements of Division 00 and/or Division 01.
- B. During construction period, keep accurate records of installations made under this Division, paying particular attention to major interior and exterior underground and concealed piping, ductwork, etc.

#### 1.13 EXCAVATING AND BACKFILLING

- A. Provide excavating and backfilling necessary for Work of this Division. Comply with provisions of Division 31, Earth Work, if applicable.
- B. Trenches shall be inspected by Code Authorities and/or Owner's Representative before and after piping is laid. Give Owner's Representative 24-hour notice for each inspection. If any trenches are filled without Owner's Representative inspection and as subsequently found to be deficient, the trenches shall be uncovered.
- C. Inspected, and then re-filled, if requested by Owner's Representative.
- D. Provide minimum 18 inches of cover or in compliance with local published frost line data (if greater than 18 inches) to finish grades or paving at water piping.
- E. For piping, provide bell holes at trench bottom to assure uniform bearing. Accurately grade trench bottoms by instrument before laying any pipe.
- F. Protect and maintain trenches in dry condition until piping has been inspected and approved. Immediately after approval, backfill trenches in tamped layers.
- G. Compact fill to satisfaction of Architect and/or Owner's Representative.

#### 1.14 CUTTING AND PATCHING

- A. Comply with requirements of Division 00 and Division 01 regarding cutting and patching. Locate and timely install sleeves as required to minimize cutting and patching.
- B. Cutting, fitting, repairing, patching, and finishing of Work shall be done by craftsmen skilled in their respective trades. Where cutting is required, cut in such a manner as not to weaken structure, partitions, or floors. Holes required to be cut must be cut or drilled without breaking out around the holes. Where patching is necessary in finished areas of the building, the Architect will determine the extent of such patching and refinishing.
- C. Repairing Roadways and Walks: Coordinate all roadway work with authorities having jurisdiction. Cut and/or bore under roadways for connection of utilities as required. Coordinate work through Contractor. Where this Contract cuts or breaks roadways, or walks to lay the piping, he shall repair or replace these sections to match existing, unless specifically identified as the responsibility of others.

#### 1.15 PAINTING

- A. Painting shall be provided under Division 09, unless specified otherwise. Leave exposed piping, materials, and equipment clean and free of rust, grease, dirt, etc. before and after painting.
- B. Factory finished equipment, fixtures, and materials which are marred, chipped, scratched, or otherwise unacceptable shall be repaired or replaced under this Division to Architect satisfaction, at no additional cost to Owner.

- C. Coordinate all painting requirements with prime bidder prior to bids.
- D. Paint all exposed piping inside and outside of building. Label all piping after painting in accordance with Section 230553. Utilize industry standard paint colors for respective system unless directed otherwise by Architect. Review proposed color scheme with Division 23 Requirements prior to ordering materials.

#### 1.16 GUARANTEE

- A. The Contractor shall guarantee all materials, equipment, and workmanship for a period of one (1) year from the date of final acceptance of the project. This guarantee shall include furnishing of all labor and material necessary to make any repairs, adjustments or replacement of any equipment, parts, etc. necessary to restore the project to first class condition. This guarantee shall exclude only the changing or cleaning of filters. Warranties exceeding one (1) year are hereinafter specified with individual pieces of equipment.
- B. If the Contractor's office is in excess of a fifty (50) mile radius of the project, he shall appoint a local qualified contractor to perform any emergency repairs or adjustments required during the guarantee period. The name of the contractor appointed to provide emergency services shall be submitted to the Architect for his approval.

### PART 2 - PRODUCTS

#### 2.1 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish manufacturers operating and maintenance instructions, parts lists and sources of supply for replacements in accordance with Division 01.
- B. Provide the following operations and maintenance data:
  - 1. Complete sets of final and correct shop drawings, maintenance and replacement parts manuals, and operating instructions, for equipment supplied.
  - 2. Bind each set within a common binder. Index and organize with a table of contents, to permit quick and convenient reference.
  - 3. Provide a minimum of five (5) days of instruction in operation and maintenance of equipment to Owner's Representative maintenance force. Design a 2-week period, convenient to Owner's Representative, during which qualified personnel, including manufacturers' technicians and authorized factory trainers shall be available for Architect/Owner's Representative instruction.

#### 2.2 RECORD DRAWINGS

- A. Provide "Record Drawings" in accordance with the Division 01, General Requirements, indicating in a neat and accurate manner a complete record of all revisions of the original design of the work.
  - 1. Include all changes and provide for an accurate record, on reproductions of the Contract drawings or on appropriate shop drawings, all deviations between the work shown and work installed.
- B. Submit for approval bound sets of the required drawings, manuals and operating instructions.

#### 2.3 IDENTIFICATION MARKINGS

- A. General: Apply identification tags, markers, etc. after insulation and field painting are completed.

### PART 3 - EXECUTION

#### 3.1 COORDINATION AND LAYOUT

- A. Study Drawings and Specifications to ensure completeness of work required.
  - 1. Include supplementary items normal to manufacturers' requirements or standard accepted trade practices as necessary to complete work, though not specifically indicated or specified.
- B. Verify measurements and conditions in field before starting work.

- C. Examine materials to which work is to be applied and notify the Architect/Owner's Representative, in writing, of any conditions existing which are detrimental to proper and expeditious installation of work.
  - 1. Starting of work shall be construed as acceptance of conditions.
- D. Confer with other trades, install work to avoid interference with other trades, and possible necessary adjustments to conform to structural conditions and work of other trades.
- E. Coordinate and set inserts and locate openings in floors and walls in new construction.
  - 1. Locate pipes and ducts to avoid interference with other work shown on the drawings and as directed by the Architect/Owner's Representative.
  - 2. Keep all concealed pipes and ducts within the enclosing construction provided.
  - 3. Arrange exposed work neatly in parallel runs and parallel with walls or structure, with uniformly spaced hangers and supports, and within the spaces assigned for each kind of work.
- F. Make coordinated layouts showing concrete work required for housekeeping pads, equipment bases and inertia masses which are cast in place, including the location of anchors and dowels.
  - 1. Coordinate the scheduling and placing of the concrete to suit the mechanical work schedules.
  - 2. Concrete housekeeping pads are to cover the full area of each piece of equipment.  
Concrete bases are to be of dimension and heights to suit the equipment.  
The forming and placing of concrete shall be provided under this specification section.

### 3.2 MAINTENANCE OF EQUIPMENT AND SYSTEM PRIOR TO FINAL ACCEPTANCE

- A. Maintain all installed equipment and systems in accordance with the manufacturer's published instructions, until final acceptance by the Architect/Owner's Representative, and take such measures as necessary to ensure adequate protection of all equipment and materials during delivery, storage, installation, operating and shut-down conditions.
  - 1. This responsibility shall include all provisions required to meet the conditions incidental to the delays pending final test of systems and equipment.
  - 2. Maintain and periodically clean all equipment until final acceptance.
- B. After installation of systems has been completed, operate the system to determine the capability of the equipment and controls to conform to the requirements of the drawings and specifications prior to performance testing.

### 3.3 DAMAGED EQUIPMENT

- A. Any and all equipment, parts, components, etc., provided under this division which is damaged by the Contract or which is received in damaged condition during shipping, transit, handling, or during installation shall be replaced. Dented, or damaged non-structural equipment jackets or surface casings such as but not limited to water heater jackets, boiler jackets, chiller insulation jackets, etc., shall either be repaired or replaced at the option of the Owner's Representative. If repaired, the finished product shall match original equipment exactly.
- B. Any equipment which develops surface rust, either through improper storage, handling or installation, shall be refinished by grinding the affected area down to bare (white) metal, then prepared with a rust preventive primer and finished with the original manufacturer's touch-up paint to match existing color.

### 3.4 EQUIPMENT INSTALLATION

- A. Locate and set equipment anchor bolts, dowels and aligning devices for all equipment requiring them. Coordinate requirements of concrete work with Contractor and other trades.
  - 1. Level the equipment and grout solid between the equipment and the surface below. Grout to be premixed grout mixed in accordance with manufacturer's specifications.
- B. The field assembly, installation and alignment of equipment is to be done under field supervision provided by the manufacturer or with inspections, adjustments and approval by the manufacturer.

C. Equipment startup.

1. Contractor shall provide qualified start-up personnel, certified by equipment manufacturer, to inspect and approve equipment and to supervise the operating tests of the equipment. System commissioning shall be performed in accordance with ASHRAE standards.

D. Equipment and system test operation.

1. Note: Equipment and system test operation is separate and apart from additional requirements of training and demonstration. Refer to individual sections for requirements regarding training and demonstration. Notify the Owner's Representative in advance of beginning the equipment and system test operation.  
All equipment testing/demonstration shall be performed in the presence of the Architect/Owner's Representative. A minimum of seven (7) days notice is required before equipment and system testing.
2. Each piece of equipment shall be operated in its system as long as required to provide proper functioning.
3. Perform an operating test of each complete system for twenty-four hours continuous operation as a minimum, or as long as required to provide coordination and proper functioning of all related systems and controls.
4. The operating criteria for each test shall be determined in advance with the Owner's Representative approval whenever seasonal conditions shall not produce a full design load on any equipment or system.
5. Certify to the Owner's Representative that all equipment is functioning properly.
6. Should the apparatus fail to meet the Contract requirements, adjust, repair or replace all defective or inoperative parts and again conduct the complete performance tests.

### 3.5 CLEANING AND ADJUSTING OF SYSTEMS

A. Blow out, clean and flush each system of piping, ductwork and equipment to thoroughly clean the systems.

1. Clean all materials and equipment, and leave in condition ready to operate and receive succeeding finishes where required.
2. Adjust and align all equipment interconnected with couplings or belts.
  - a. Adjust valves of all types and operating equipment of all types to provide proper operation.
  - b. Remove and clean elements in all steam trap bodies.
  - c. Clean all strainers. Replace temporary construction screens with new permanent screens.

B. Permanent equipment operated during construction shall not be abused or be used in service different from its design application.

1. Temporary disposable filters shall be used during temporary operation.
2. All expendable media, including belts used for temporary operation and similar expendable materials shall be replaced just prior to acceptance.
3. Packing boxes of equipment operated during construction must be replaced just prior to system acceptance, using materials and methods specified by the supplying manufacturer.

C. Equipment furnished with factory finishes where damaged shall be retouched and repainted to present a new appearance.

D. Furnish and maintain protection for all of the work whether completed or in progress.

1. Furnish and install coverings and enclosures as required.

E. New and existing operating equipment and systems shall be clean and dust free inside and out.

1. Concealed and unoccupied areas such as plenums, pipe and duct spaces and Equipment Rooms shall be free of rubbish and swept, vacuumed, or wiped clean at time of acceptance.



### 3.6 CONTRACTOR REQUESTED FIELD OBSERVATIONS

- A. During the course of, and at stages appropriate to the progress of construction, the Contractor may request field observations of the design professional. If the field observation is a request of and by the Contractor, the Contractor shall provide all necessary ladders, scaffolding, lifts, safety harnesses or other equipment in order for the Architect to safely and adequately perform the requested observations.
  - 1. Requests for observations shall be made a minimum of seven (7) days in advance of the requested date of observation.
  - 2. All equipment, ladders, lifts, safety nets, scaffolding, etc., shall be provided and in place for the use of the Architect.
  - 3. All equipment panel covers, electrical panels, or other equipment shall be opened by the Contractor for viewing by the Architect.
  - 4. The Contractor shall make available a mechanic or technician of that field in order to answer questions of the designer, make any and all adjustments and/or corrections and to assist the Architect.

### 3.7 TESTING AND BALANCING

- A. Refer to Specifications Section 230593.

### 3.8 PAINTING

- A. General painting is typically performed by the Division 09 Contractor. This Contract shall however, either perform specialized painting as called for below in the following conditions or he shall advise the Contractor of these requirements as follows:
  - 1. Thoroughly clean all surfaces, requiring prime painting, of rust, loose scale, oil and grease.
  - 2. Dry surfaces before painting.
  - 3. Do not paint controls, nameplates, labels or sprinklers.
- B. Paint all equipment unless otherwise specified not to be painted at the factory with one prime coat of rust prohibitive paint.
- C. Provide field painting as follows:
  - 1. All exposed iron work, including un-insulated ferrous piping and conduit system components, hangers, supports, equipment bases, and apparatus; prime coat with a red lead-free paint.
  - 2. Un-insulated duct work and casing exposed to view and exposed galvanized surfaces of conduit and piping and of equipment prime painted at the shop: Prime coat, zinc chromate for galvanized surfaces.
  - 3. Inside of all duct work where visible through registers and grilles: One coat of flat black paint.

### 3.9 CONNECTIONS TO EQUIPMENT

- A. Provide mechanical connections to equipment and fixtures requiring such connections which are supplied by Architect/Owner's Representative or under other divisions.
- B. Provide unions, nipples, adapters, valves, flexible connections, and other trim required for final connections for each such fixture or item of equipment, as required for complete operation, servicing, and maintenance.

### 3.10 WORKMANSHIP

- A. Perform all work in a practical, neat and workmanlike manner with mechanics skilled in work, and using the best practices of the trade involved.
- B. No work shall be concealed until it has been inspected and approved by the Architect/Owner's Representative.
- C. Workmanship or materials not meeting with requirements of the specifications and drawings and satisfaction of the Architect/Owner's Representative shall be rejected and immediately replaced in an acceptable manner, without additional cost to the Architect/Owner's Representative.

### 3.11 LUBRICATION

- A. All equipment furnished, installed, or connected under this division, shall be inspected for proper lubrication when connected and before operation of the equipment is begun, as recommended by the Manufacturer.
- B. The Contractor for the work of this division shall be held responsible for any damage to equipment that is operated without having been properly lubricated.

### 3.12 USE OF PREMISES AND CLEANING

- A. Remove and dispose of all waste materials and rubbish due to all construction operations under the Contract, except as otherwise noted, and keep the building free from rubbish and dirt caused by his and/or his Sub-Contractors' employees.
  - 1. During the entire progress of the work, rubbish removal shall be made frequently so as to prevent any potential safety or health hazard.
- B. Upon completion of the work, remove all protection, paint, putty, and other stains from all fixtures and glass and leave the premises thoroughly broom cleaned.

### 3.13 CUTTING, ALTERING AND PATCHING

- A. Provide all cutting, chasing, drilling, altering and rough patching required for the work of this division.
- B. Do all shoring, bracing, cutting, patching, piecing out, filling in, repairing and refinishing of all present work as made necessary by the alteration and the installation of new work.
- C. All holes and openings occurring in the existing floors after equipment, partitions, floors, steel work, conduits and pipes are removed or installed shall be closed up with materials similar to the adjacent work.
- D. The size and location of items requiring an opening, chase or other provisions to receive it shall be given by the trade requiring same in ample time to avoid undue cutting of any new work to be installed. These provisions shall not relieve the Contractor from keeping other trades informed as to the required opening, chases, etc., nor from responsibility for the correctness thereof, nor for cutting and repairing after the new work is in place.
- E. Include all cutting, repairing, and patching in connection with the work that may be required to make the several parts come together properly and fit it to receive or be received by the work of other trades, as shown on the drawings and/or specified, or reasonably implied by the drawings and specifications.
- F. All repairing, patching, piecing-out, filling-in, restoring and refinishing shall be neatly done by mechanics skilled in their trade to leave same in condition satisfactory to the Architect/Owner's Representative.
- G. Materials and their methods of application for patching shall comply with applicable requirements of the specifications.
  - 1. Materials and workmanship not covered by the specifications and items of work exposed to view adjoining existing work to remain shall conform to similar materials and workmanship existing in or adjacent to the spaces to be altered.
- H. Cutting, repairing, and patching shall include all items shown on the drawings, specified in the specifications or required by the installation of new work or the removal of existing work.
- I. Remove partitions, walls, suspended ceilings, etc., as necessary to perform the required alterations or new construction work.
  - 1. Avoid damage to construction and finishes that are to remain.
- J. Protect and be responsible for the existing building, facilities and improvements if any.

1. Any disturbance or damage to the work, the existing building, and improvements, or any impairments of facilities resulting from the construction operations, shall be promptly rectified, with the disturbed, damaged, or impaired work, restored, repaired or replaced at no extra cost.
- K. All alterations which are not indicated on the drawings nor specified herein but necessary to make good existing work disturbed by reason of the work shall be restored to a condition satisfactory to the Architect/Owner's Representative.
- L. All holes in masonry floors and walls are to be core drilled.
- M. Disturbed concrete and /or cement floor areas shall be patched with approved type latex mortar.
  1. When cement mortar is used for patching, the surfaces shall be depressed a minimum depth of one inch (1").
- N. Reinstall all weather protection work in waterproof manner.
- O. Openings in roofs:
  1. Openings in roofs shall be kept properly plugged and caulked at all times, except when being worked on, to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed.
- P. Temporary openings.
  1. All temporary openings cut in walls, floors or ceilings for pipe or duct work shall be closed off with transite or an equally non-combustible material except when mechanics are actually working at the particular opening.

### 3.14 USE OF PERMANENT SYSTEMS:

#### A. Heating System:

1. The Contractor may, at his option, utilize the permanent heating systems provided under this Contract to provide space heating prior to Project completion date. The fuel for such space heating and for required tests of heating equipment shall be provided by Contractor.
2. The heating system shall be operated only by qualified personnel, and shall be operated with all auxiliaries, and in accordance with manufacturer's instructions and good operating practice. If at any time the Owner's Representative determines that the equipment is being improperly operated or maintained, Contractor may be directed to disconnect its use.
3. Heating systems shall be operated and controlled to prevent temperature in any room or space in any building from exceeding 90 deg. F.
4. Systems may be activated without diffusers and registers in place, but filters with same efficiency as those specified shall be provided both in air handling equipment and at return air grille locations. Filter return air entering duct work, to prevent return air duct work from accumulating dust or otherwise becoming dirty.
5. Contractor shall, prior to final acceptance of the Work, place heating systems and related equipment in a condition equal to new.

#### B. Air Conditioning System:

1. The Contractor may, at his option, utilize the permanent air conditioning systems provided under this Contract to provide space cooling prior to the Project completion date.
2. The fuel, electricity or other energy required for space cooling and for any subsequent operation or testing shall be provided for by the Contractor.
3. The cooling system shall be operated only by fully qualified personnel and shall be operated with all auxiliaries, and in accordance with manufacturer's instructions and good operating practice. Start up of equipment for use by the Contractor shall not commence any warranty period.
4. Cooling systems shall be operated and controlled to prevent temperature in any room or space in any building from falling below 70 deg. F.
5. Systems may be activated without diffusers and registers in place, but filters with same efficiency as those specified shall be provided both in air handling equipment and at return air grille locations. Filter

all return air entering duct work, to prevent return air duct work from accumulating dust or otherwise becoming dirty.

6. Contractor shall, prior to final acceptance of the Work, place cooling systems and related equipment in a condition equal to new.

### 3.15 PENETRATIONS THROUGH FIRE SEPARATIONS

- A. Pack annular space between sleeve and pipe (insulation) and / or conduit in fire rated construction with fire retardant putty, sealant and / or caulk in accordance with listed assemblies utilized on the project. Material shall be non-asbestos based and installed in accordance with manufacturers instructions for fire rating required.
- B. Penetrations of multiple items and penetrations with annular space greater than 1/2" shall be provided with approved backing material in accordance with manufacturer's instructions.
- C. Fire retardant sealer and system shall meet ASTM E-84, ASTM E-814, and UL-1479.

END OF SECTION 23 00 10

**SECTION 23 00 20**  
**BASIC MECHANICAL REQUIREMENTS**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 23. It expands and supplements the requirements specified in sections of Division 01.

**1.3 ACCESSIBILITY**

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. Verify exact location and placement of all access panels with/through Architect prior to any equipment rough-in.
- B. Extend all grease fittings to an accessible location.
- C. Refer to the Division 08 Section: Access Doors.

**1.4 ROUGH-IN**

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 23 for rough-in requirements.

**1.5 MECHANICAL INSTALLATIONS**

- A. Coordinate mechanical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. 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.
- E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- I. Coordinate the installation of mechanical materials and equipment above ceilings with suspension system, light fixtures, and other installations.

- J. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

#### 1.6 MECHANICAL COORDINATION DRAWINGS

- A. Prepare and submit a set of coordination drawings showing major elements, components, and systems of mechanical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing and maintaining insulation, servicing, and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- B. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. Mechanical equipment room layouts;
  - 2. Specific equipment installations, including:
    - a. Ductwork and diffusers;
    - b. Pumps (new and existing) and piping connections
    - c. Air Handling equipment, fan coils and terminal units with accessories requirements.
  - 3. Work in pipe spaces, chases, trenches, and tunnels;
  - 4. Exterior wall penetrations;
  - 5. Ceiling plenums which contain piping, ductwork, or equipment in congested arrangement;
  - 6. Installations in mechanical riser shafts, at typical sections and crucial offsets and junctures;
  - 7. Division 23 Contractor shall furnish drawings, to Contractor, once approved by reviewing Architect, to fully coordinate with all trades and subcontractors required. Failure to fully coordinate via this process shall not relieve the contractor of his responsibility to coordinate structural supports, electrical service routing of mechanical systems and provisions for required access.

#### 1.7 CUTTING PATCHING AND SEALING OF PENETRATIONS

- A. This Article specifies the cutting and patching of mechanical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
- B. Refer to the Division 01 Section: CUTTING AND PATCHING for general requirements for cutting and patching.
- C. Refer to Division 26 Section for BASIC ELECTRICAL REQUIREMENTS for requirements for cutting and patching electrical equipment, components, and materials.
- D. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- E. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.
- F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
- G. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
  - 1. Uncover Work to provide for installation of ill-timed Work.
  - 2. Remove and replace defective Work.
  - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
  - 4. Remove samples of installed Work as specified for testing.
  - 5. Install equipment and materials in existing structures.
  - 6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.

- H. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- I. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- J. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- K. Locate identify, and protect mechanical and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When transit services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover.
- L. Seal all penetrations of building envelope air and water tight. For complete closure of openings, where necessary, provide 1/8" thick elastomeric barrier anchored to materials penetrating building envelope and adjacent envelope surfaces involved - seal connections with caulk and mechanical fasteners. Refer to Architectural Sections on joints and sealants. Seal all conduit systems communicating between conditioned and unconditioned spaces. Coordinate all work with and through prime bidder and other trades. Unless otherwise directed, caulk sealant shall be long lasting polyurethane based products, resistant to UV exposure, installed in accordance with manufactures instructions. Sealant joints shall withstand building pressures variance with respect to ambient of 0.25 inches water gauge, with no leakage in terms of air and or water vapor.

#### 1.8 MECHANICAL SUBMITTALS

- A. Refer to the Conditions of the Contract (General and Supplementary) and Division 01 Section: Submittal Procedures for submittal definitions, requirements, and procedures.
- B. Submittal of bound shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect will not be processed.

### PART 2 - PRODUCTS

#### 2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to the Instructions to Bidders for requirements in selecting products and requesting substitutions.

#### 2.2 PRODUCT LISTING

- A. Prepare listing of major mechanical equipment and materials for the project. A sample schedule is included at the end of this Section to complete this requirement.
- B. Provide all information requested.
- C. Submit this listing as a part of the submittal requirement specified in the Division 01.
- D. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.
- E. Provide products which are compatible within systems and other connected items.

#### 2.3 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Locate nameplates in an accessible location.

## 2.4 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Coordinate deliveries of mechanical 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.

## 2.5 RECORD DOCUMENTS

- A. Refer to the Division 01 Section: Closeout Procedures for requirements. The following paragraphs supplement the requirements of Division 01.
- B. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C. Mark Specifications to indicate approved substitutions, Change Orders, actual equipment and materials used.

## 2.6 OPERATION AND MAINTENANCE DATA

- A. Refer to the Division 01 Section for 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 01 for Maintenance Data, include the following information:
  - 1. Description of function, normal operating characteristics and limitations, performance 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.
- C. Submit in accordance with Section 017800.
- D. Use multiple binders if a single binder would exceed 2-1/2 inches in thickness; arrange the data in the same sequence as the specification sections; delete or mark through extraneous data.
- E. Provide tab pages with metal or plastic reinforced holes to separate each major item or closely related group of items with typed item names on the tabs. Supply a table of contents at the beginning of each volume listing at items, the manufacturers and the name, address and phone number of the nearest authorized service representative.
- F. A copy of the completed manual shall be submitted to the Contracting Officer one week before the user instruction for perusal. This copy will be returned to the Contractor with the user, comments. These comments shall be incorporated in the final copies of the manual. The Contractor shall obtain a signed receipt for the manual.



- G. The O & M Manual outline shall be prepared in two parts along the lines suggested in the 2019 HVAC Applications, Chapter 40.
- H. All contents shall be project specific, typewritten.

## 2.7 WARRANTIES

- A. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division 23, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment to include 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.

## 2.8 CLEANING

- A. Refer to the Division 01 Section for general requirements for final cleaning.
- B. Refer to Division 230593 Section: TESTING, ADJUSTING, AND BALANCING for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

# PART 3 - EXECUTION

## 3.1 WARRANTIES

- A. Refer to the Division 01 Section for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division 23, into a separated set of vinyl covered, three ring binders, tabulated, and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment to include 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.

## 3.3 CLEANING

- A. Refer to the Division 01 Section for general requirements for final cleaning.
- B. Refer to Division 23 Section: TESTING, ADJUSTING, AND BALANCING for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

END OF SECTION 23 00 20



## SECTION 23 05 10

### ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT



#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

##### 1.2 SCOPE OF WORK

###### A. Compliance with National Electric Code Requirements

###### 1. Minimum Requirements:

- a. The requirements of this Division supercede the "minimum" requirements of National Codes such as NEC in many areas. Where reference to this National Code is made, it is understood that the requirements of these codes are meant to indicate the "minimum" requirements required by these Contract Documents and are not to infer that these "minimum" requirements eliminate or in any way diminish the requirements of individual sections of these Contract Documents.
- b. Wherever compliance with this National Code is required, it shall be taken as a minimum requirement and applicable whenever the Contract Documents are silent with respect to specific requirements or installation procedures. The Contractor shall as a minimum, comply with the more stringent of the requirements.

###### B. Interlock Wiring for Mechanical Equipment

- 1. Interlocks & Wiring of Mechanical Equipment: It is the intent of the contract documents to note or include most of the obvious physical wiring, conduit, relays, and necessary interlocks between various pieces of mechanical/electrical equipment. Plans, details, specifications and drawings however, do not typically indicate the exact extent and encompassment of all required mechanical/electrical interlocks, routing, control voltages, conduit, wiring diagrams, etc., between mechanical and electrical devices and equipment that may be required for the proper operation and sequencing of equipment. Also, typically not indicated on the drawings is the differentiation between field installed and factory provided wiring because of the significant differences in requirements between various equipment manufacturer's requirements and/or job site conditions. It is the responsibility of this contractor to first verify that all mechanical related items affecting other trades are properly coordinated, accounted for and included in pricing prior to bid date. Additional costs for interlocks after bids are received will not be allowed for failure to coordinate. Reference is made to coordination and responsibility of providing the required wiring diagrams and requirements between the various subs, etc. It remains however, the responsibility of this Contractor as further described in the following articles, to properly coordinate, be responsible for, and to allow for any and all costs associated with the requirements of the equipment manufacturer's recommendations in order to preserve guarantees and warranties. (Note: For informational purposes only) - Typical mechanical/electrical/control/wiring interlocks covered under this section include but are not limited to the following examples:

- a. Domestic water pump interlocks with aquastats & thermostats.
- b. Exhaust fans and supply fan general ventilation interlocks.
- c. Smoke detector interlocks with supply air fans.
- d. Hi-Limit Temperature (firestat) interlocks with supply air fans.
- e. Lo-Limit Temperature (freezestat) interlocks with supply air fans.
- f. Interlocks between automatic safety float switches in emergency drain pans and respective fan motors and/or condensing units.
- g. Interlocks between Air Handling Unit "Kill" switches and fan motor starters.
- h. Damper interlocks between required fire suppression systems.
- i. Fresh air damper interlocks with supply air fans.

- j. Two speed fan motors, number of conductors, and interlocks between motor starters and fan speed controllers.
- k. High limit temperature interlocks with unit heater thermostats.
- l. High and low water level limit interlocks with sump and ejector pumps.
- m. All other factory wired mechanical equipment requiring field installed connections and interfaces.

### 1.3 SUMMARY OF RESPONSIBILITY

- A. In order to ensure proper operation of mechanical equipment installed, it is the intent of this section of the specifications to ensure that the Division 23 Contractor is the ultimate party responsible for the proper electrical installation of the equipment provided under the technical specifications of this Division. Unless the Division 23 Contractor is fully licensed and qualified to provide a complete electrical installation, he shall obtain the services of a fully qualified electrical Contractor to perform those services required to provide a complete and operational system. If, however, the services of other Contractors or sub-contractors are required by the Division 23 Contractor in order that the equipment provided is to operate and perform as specified, the Division 23 Contractor shall obtain, pay for, and coordinate the services of such Contractor(s) in order to provide a complete a fully operational mechanical system. The Division 23 Contractor shall be fully responsible for the work of all sub-contractors and shall fully warrant their work in accordance with the requirements of Division 01 of these specifications.
- B. This section includes the basic requirements for field installed electrical conduits, power circuits, breakers, wiring, interlocks, and other electrical components which are to become an integral part of mechanical equipment provided under Division 23. All work performed under this section shall fully as a minimum, comply with Division 26 Specifications and National Electric Code - (latest edition) and shall be provided as listed below:
  - 1. All "field-installed" interlock and/or control/power wiring necessary to provide a complete and operating mechanical system shall be ultimately provided by, and be the responsibility of the Division 23 Contractor. These components shall include, but are not limited to the following examples:
    - a. Automatic Temperature Control panels
    - b. Installation and connection of factory installed motors
    - c. Variable frequency drives
    - d. Motors (single & multi-speed)
    - e. Motor starters (single and multi-speed) for all Division 23 equipment
    - f. Fire protection control panels
    - g. Supply, return, & exhaust fan interlocks
    - h. Plumbing fixture automatic flush valves
    - i. Interlocks between domestic water circulating pumps & aquastats
    - j. Exhaust fan/supply fan interlocks
    - k. Filters at AHU's
    - l. AHU, hi-limit temperature interlocks, lo-limit temperature interlocks, smoke detectors, and other interlocks related to Life Safety protection.
    - m. Other various interlocks between items of mechanical equipment, safeties, and field wired interconnections.
- C. It is the responsibility of the Division 23 Contractor to fully coordinate the electrical requirements of his mechanical equipment with the Division 26 Contractor prior to bidding and to ensure that other contractors and divisions are made aware of the requirements of his equipment that he intends to provide. The Division 23 Contractor shall provide wiring and control diagrams of all mechanical, air conditioning, ventilation, plumbing and /or fire protection equipment clearly delineating between factory wiring and field installed wiring. The mechanical contractor shall ensure that all field installed wiring, interlocks, etc., required to provide a complete and operable system are inclusive with his bid.
- D. Specific electrical power requirements (i.e., horsepower and electrical characteristics) where known, for mechanical equipment are scheduled on the Drawings or within the body of the individual technical specifications.
- E. Low Voltage Wiring: Low voltage wiring is not typically shown on the contract documents or plans. It remains however, the responsibility of the Division 23 Contractor to fully coordinate the low voltage electrical requirements of his mechanical equipment with the Division 26 Contractor prior to bidding and to ensure that other Contractors and Divisions are made aware of the requirements of his equipment that he intends to provide. The Division 23 Contractor shall also provide the low voltage wiring and control wiring diagrams of all

mechanical, air conditioning, ventilation, plumbing and /or fire protection equipment clearly delineating between factory wiring and field installed wiring.

1. The Division 23 Contractor shall coordinate with the Division 26 Contractor for all necessary power requirements.

#### 1.4 REFERENCES

- A. NEMA Standards 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. As a minimum, comply with National Electrical Code (NFPA 70).

#### 1.5 SUBMITTALS

- A. Motors, Starters, & VFD Drives: Provide manufacturer's product data. If starters are an integral part of packaged mechanical equipment, then a separate starter submittal is not required.
- B. Submit product data for motors, starters, variable frequency drives and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

#### 1.6 QUALITY ASSURANCE

- A. All electrical components and materials shall be UL labeled.

### PART 2 - PRODUCTS

#### 2.1 MOTORS

- A. The following are basic requirements for simple or common motors. For special duty motors, more detailed and specific requirements are specified in Section 230513 – "Electric Motors".
  1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
  2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
  3. Temperature Rating: Rated for 50 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
  4. Starting capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.
  5. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
  6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
    - a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
    - b. Bearings: Ball or roller or pillow block bearings with inner and outer shaft seals; re-greaseable, except permanently sealed where motor is normally inaccessible for regular maintenance; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
  7. Enclosure Type: Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation; totally enclosed, fan cooled for exterior applications or where specifically indicated on drawings.
  8. Overload protection: Built-in thermal overload protection.
  9. Noise rating: "Quiet"
  10. Efficiency: "Premium Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a

higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, test method B.

11. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

## 2.2 STARTERS, ELECTRICAL DEVICES, AND WIRING

### A. Motor Starter Characteristics:

1. Enclosures: Unless otherwise specifically identified, provide NEMA 1, general purpose enclosures with padlock ears, except in wet or exterior locations, where enclosures shall be NEMA 3R with conduit hubs, or units in hazardous or dust laden atmospheres or other locations which shall have NEC rating for that particular proper class and division.
2. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

### B. Magnetic Starters:

1. Refer to Section 230514 - "Motor Starters" for full requirements of motor starters.
2. As a minimum, provide the following items on each motor starter:
  - a. Maintained contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
  - b. Trip-free thermal overload relays, each phase.
  - c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23- "Building Automation System" controls sections.
  - d. Built-in 120 volts control circuit transformer, fused from line side, where incoming electrical service exceeds 240 volts.
  - e. Lockable "Off" position handle.
  - f. H-O-A selector switch.
  - g. Externally operated manual reset.
  - h. Under-voltage release or protection.

### C. Motor connections:

1. Flexible conduit, weatherproof type where installed in damp or wet locations as defined by the NEC, except where plug-in electrical cords are specifically indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify equipment physical size and clearances required.
- B. Verify electrical interlocks required.

### 3.2 THERMAL STOPS & BARRIERS

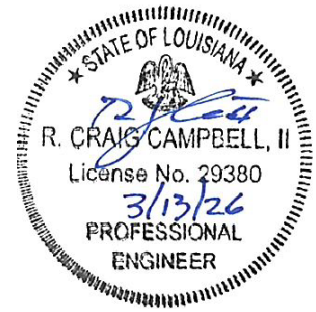
- A. Thermal Barriers: Where electrical equipment, conduit, wiring, etc., penetrates or comes into contact with cold or hot mechanical equipment, provide thermal barriers to prevent intrusion of unconditioned air into mechanical equipment or to prevent electrical devices from sweating or accumulating condensation.
  1. Examples: Examples of the above include but are not limited to:
    - a. Air handling conduit penetrations at or into AHU casings.
    - b. Smoke detectors attachment to hot or cold ductwork.

### 3.3 TRAINING & DEMONSTRATION

- A. Provide training as described in individual technical specifications.

## END SECTION 23 05 10

**SECTION 23 05 13  
ELECTRIC MOTORS**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. This Section includes basic requirements for all motors connected to mechanical equipment. It includes motors that are factory-installed as part of equipment and appliances as well as field-installed motors.

**1.3 QUALITY ASSURANCE**

- A. As a minimum, comply with applicable local, state and federal codes.
- B. As a minimum, comply with applicable requirements of recognized industry associations which promulgate standards for the various trades. (See individual Sections of Division 23).
- C. Employ only qualified personnel for this work. Employ competent, qualified mechanics to supervise the work.
- D. As a minimum, comply with ASHRAE Standard 90.1 - 1999 (or latest edition) for motors.
- E. As a minimum, comply with NFPA 70, "National Electrical Code." (Latest Edition)
- F. NRTL Listing: Provide NRTL listed motors.
- G. Term "Listed": As defined in "National Electrical Code," Article 100.
- H. Listing Agency Qualifications: "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- I. As a minimum, comply with NEMA Standard MG 1, "Motors and Generators."
- J. As a minimum, comply with UL 1004, "Motors, Electric."

**PART 2 - PRODUCTS**

**2.1 MOTORS, GENERAL**

- A. General: Requirements below apply to motors covered by this Section except as otherwise indicated, for motors classified as simple or common motors (Section 230510).
  - 1. Motors 1.0 HP and Larger: Polyphase.
  - 2. Motors Smaller Than 1.0 HP: Single-phase.
  - 3. Frequency Rating: 60 Hz.
  - 4. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
    - a. 120 V Circuit: 115 V - motor rating.
    - b. 208 V Circuit: 200 V - motor rating.
    - c. 240 V Circuit: 230 V - motor rating.
    - d. 480 V Circuit: 460 V - motor rating.
  - 5. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.

6. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.
7. Temperature Rise: Based on 40 deg. C ambient except 50 deg. C when otherwise indicated in equipment specifications or on equipment schedules on Plans.
8. Enclosure: Open drip proof except where exposed to elements, weather, or where specifically called for on Drawings and/or equipment specifications.

B. Manufacturers

1. Acceptable Manufacturers: Subject to the following requirements, provide motors from one of the following manufacturers:
  - a. Baldor
  - b. Marathon
  - c. U.S. Motors
  - d. General Electric
  - e. Reliance

## 2.2 POLYPHASE MOTORS

A. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated in equipment specifications.

1. NEMA Design Letter Designation: "B" with 1.15 Service Factor.
2. Multi-Speed Motors: Separate winding for each speed.
3. Energy Efficient Motors: Premium Efficiency.
4. Motors shall be complete with shaft grounding rings.

B. Variable Speed Motors for Use with Solid-State Drives:

1. NEMA Standard MG 1, Part 31, "Definite Purpose Inverter Fed Motors", continuous duty, Design B, squirrel-cage induction units with ratings, characteristics, and features coordinated with and approved by the drive manufacturer. The motor shall include 1600-volt slot and phase paper insulation for protection against damage due to reflected waves.
2. Internal Thermal Overload Protection for Motors: Protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.
3. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading of the application.

## 2.3 SINGLE-PHASE MOTORS

A. General: Conform to the following requirements except as otherwise indicated.

B. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.

1. Permanent Split Capacitor.
2. Split-Phase Start, Capacitor-Run.
3. Capacitor-Start, Capacitor-Run.

C. Shaded-Pole Motors: Use only for motors smaller than 1/20 hp.

D. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens the power supply circuit to the motor, or a control circuit arranged for external connection. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.

E. Bearings, belt connected motors, and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, pre-lubricated sleeve bearings may be used for other single-phase motors.



## 2.4 MOTOR EFFICIENCIES

### A. Premium Efficiency Motors:

1. All motors shall bear the NEMA "Premium" label and shall meet or exceed the following nominal energy efficiency levels prescribed below for Design A or B continuous rated:

*(The remainder of this page intentionally left blank)*

Table 1 Nominal Efficiencies For “NEMA Premium” Induction Motors  
Rated 600 Volts or Less (Random Wound)

2.5 Open Drip Proof		Totally Enclosed Fan Cooled				
HP	6-Pole	4-Pole	2-Pole	6-Pole	4-Pole	2-Pole
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
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4
250	95.4	95.8	95.0	95.8	96.2	95.8
300	95.4	95.8	95.4	95.8	96.2	95.8
350	95.4	95.8	95.4	95.8	96.2	95.8
400	95.8	95.8	95.8	95.8	96.2	95.8
450	96.2	96.2	95.8	95.8	96.2	95.8
500	96.2	96.2	95.8	95.8	96.2	95.8

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: The following requirements apply to field-installed motors.
- B. Install motors in accordance with manufacturer's published instructions and the following:
  - 1. Direct Connected Motors: Mount securely in accurate alignment.
  - 2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

### 3.2 COMMISSIONING

- A. Check operating motors, both factory and field-installed, for unusual conditions during normal operation. Coordinate with the commissioning of the equipment for which the motor is a part.
- B. Report unusual conditions.
- C. Correct deficiencies of field-installed units.

### 3.3 TRAINING AND DEMONSTRATION

- A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
  - 1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
  - 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 01, for Closeout Submittals and Division 23, Section 230020 - "Basic Mechanical Requirements."
  - 3. Provide Service Manuals for each motor specified.
- B. Provide three (3) hours of factory authorized training to Owner's operating personnel.
  - 1. Schedule training with at least seven (7) days advanced notice to Owner's Representative.
  - 2. Refer to Section 230010 - "Mechanical General Provisions" for video taping requirements.

END OF SECTION 23 05 13



**SECTION 23 05 14  
MOTOR STARTERS**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. All motor starters specified under this section shall be provided by the same manufacturer.
- B. All motor starters installed in return air plenums shall be plenum rated.
- C. Extent of motor starter work is indicated by drawings and schedules. All motors and mechanical equipment provided with motors supplied by the Division 23 Contractor shall be also provided with Motor Starters and/or Variable Frequency Drives. It is the responsibility of the Division 23 Contractor to ensure that all Motor Starters/VFD's are sized and suitable for the intended purpose of the mechanical equipment provided.
- D. Disconnecting means unless integral to the Starter/VFD shall be provided by the Division 26 Contractor.
- E. Types of motor starters specified in this section include the following:
  - 1. Magnetic.
  - 2. Manual.

**1.3 QUALITY ASSURANCE**

- A. Manufacturers: Firms regularly engaged in manufacturer of motor starters, of types, ratings and characteristics 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 utilizing motor starters similar to that required for the project.
- C. NEC Compliance: As a minimum, comply with NEC as applicable to wiring methods, construction, and installation of motor starters.
- D. NFPA Compliance: As a minimum, comply with applicable requirements of NFPA 70E "Standard for Electrical Safety Requirements for Employee Workplaces".
- E. UL Compliance: As a minimum, comply with applicable requirements of UL 468A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", and UL 508, "Electrical Industrial Control Equipment", pertaining to installation of motor starters.
- F. IEE Compliance: As a minimum, comply with applicable requirements of IEE STD 241, "Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to motor starters.
- G. NEMA Compliance: As a minimum, comply with applicable portions of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies", Maximum), pertaining to motor controllers/starters and enclosures.

**1.4 SUBMITTALS**

- A. Product Data: Submit manufacturer's data on motor starters.

- B. Shop Drawings: Submit layout drawings of motor starters showing accurately scaled equipment locations and spatial relationships to associated motors.
- C. Wiring Diagrams: Submit wiring diagrams for motor starters showing connections to electrical power panels, feeders, and equipment. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.
- D. Maintenance Stock - Fuses: For types and ratings required, furnish additional fuses, amounting to one set for every 10 installed units, but not less than 5 sets of each.

## 1.5 DELIVERY & STORAGE

- A. Motor Starter(s) shall be stored and handled per manufacturer's recommendations.
  - 1. Deliver motor starter(s) from the factory properly secured, crated, and protected with factory plastic shrink wrap or other protective wrap.
  - 2. Lift and support motor starter(s) with the manufacturer's designated lifting or supporting points.
  - 3. Disassemble and reassemble motor starter(s) as required for movement into the final location following manufacturer's written instructions.
  - 4. Deliver motor starter(s) as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
  - 5. Store motor starter(s) to prevent damage to starter(s). Store units out of the elements and maintain factory protective covering until ready for installation.
- B. Lift and support motor starter(s) with the manufacturer's designated lifting or supporting points.
- C. Disassemble and reassemble motor starter(s) as required for movement into the final location following manufacturer's written instructions.
- D. Deliver motor starter(s) as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering motor starters which may be incorporated in the work are as follows:
  - 1. Allen-Bradley Co.
  - 2. Cutler Hammer Products, Eaton Corp.
  - 3. General Electric Co.
  - 4. GTE Products Corp.
  - 5. Gould, Inc.
  - 6. Square D Co.
  - 7. Westinghouse Corp.
  - 8. Siemens, Inc.

### 2.2 MOTOR STARTERS

- A. General: Except as otherwise indicated, provide motor starters and ancillary components which as a minimum, comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation.
- B. Magnetic Starter Requirements: Provide magnetic starters for motors 3/4 hp and larger, and for smaller motors where interlock or automatic operation with other equipment is indicated. Include the following accessories for all starters:
  - 1. Provide UL Listing as a unit. Starters assembled with only UL components will not be acceptable.
  - 2. Maintained-contact push buttons and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
  - 3. Trip-free thermal adjustable overload relays, each phase.

4. Interlocks, pneumatic switches, and similar devices as required for coordination with control requirements of Section 230900 – “Building Automation System” sections.
  5. Built-in 120-volt control circuit transformer with fused secondary, fused from line inside, where service exceeds 240 volts.
  6. Pilot Light; Red - “On”
  7. Pilot Light; Green - “Off”
  8. Auxiliary Contact Block
  9. Externally operated manual “Reset” overload relay button mounted on door/cover of the unit.
  10. 2-Point terminal strip with “H-O-A” Selector switch
  11. Hinged cabinet cover. Lift cover is not acceptable.
  12. Enclosure - Rated for exposure indicated on plans unless otherwise specifically indicated.
  13. Under-voltage release or protection.
  14. Lockable Handle “OFF” position switch.
- C. AC Fractional HP Manual Starters: Provide manual single-phase fractional HP manual motor starters, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms; and with one-piece melting alloy type thermal units. Starter to become inoperative when thermal unit is removed. Provide starters with double break silver alloy contacts, visible from both sides of starter; green pilot lights, and switch capable of being padlocked “OFF”. Enclose starter unit in NEMA Type 1, 12, 4X, or 3R general purpose enclosure suitable for surface mounting according to the environment in which the starter is installed. Coat with manufacturer's standard color finish.
- D. Full Voltage Non-Reversing Starters: Starters for three phase motors 10 horsepower and below.
1. Provide combination type starter/disconnect, full voltage non- reversing (FVNR), with magnetic NEMA rated contactors rated for horsepower of motor served.
  2. Adjustable trip magnetic circuit breaker disconnect (motor circuit protector) capable of being padlocked in the open position (power off).
  3. 10K AIC minimum fault rating with higher rating, when necessary, due to available fault levels.
  4. Starters shall have a fused 100VA minimum control transformer (120V, unless required otherwise).
  5. Provide HOA switch, push to test operating pilot light, solid state overload relays set for actual motor nameplate full load amps, and phase failure and phase reversal protection relays.
  6. Provide minimum two (2) N.O. and two (2) N.C. auxiliary contacts and terminal blocks factory pre-wired for field wiring.
  7. Starters shall be housed in a NEMA 1 enclosure for indoor applications and NEMA 3R enclosure for outdoor or wet locations. NEMA 12 enclosures shall be provided for installation in return air plenums or dirty/dusty indoor locations. NEMA 4X Stainless Steel enclosures shall be installed in corrosive environments.
  8. Coat with manufacturer's standard color finish.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF MOTOR STARTERS

- A. Install motor starters, in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL, and NEMA standards, to ensure that products fulfill requirements.
- B. Coordinate with other work including motor and electrical wiring/cabling work, as necessary to interface installation of motor starters with other work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.
- D. Install fuses in fusible disconnects, if any.

### 3.2 ADJUSTING AND CLEANING

- A. Inspect electrical starter's operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

- B. Touch-up scratched or marred surfaces to match original finish.

### 3.3 FIELD QUALITY CONTROL

- A. Subsequent to connecting wire/cables, energize motor starter circuitry and demonstrate functioning of equipment in accordance with requirements; where necessary correct malfunctioning units, and then retest to demonstrate compliance. Ensure that direction of rotation of each motor fulfills requirements.

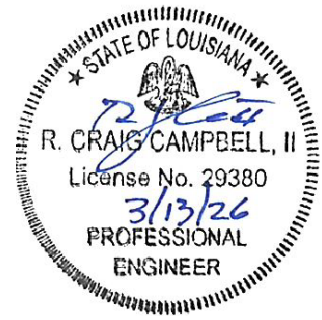
### 3.4 TRAINING & DEMONSTRATION

- A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
  - 1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
  - 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 01, Section 017780 - "Closeout Submittals" and Division 23, Section 230020 - "Basic Mechanical Requirements."
  - 3. Provide Service Manual for each motor starter specified.
- B. Provide three (3) hours of factory authorized training.
  - 1. Refer to Section 230010 - "Mechanical General Provisions" for video taping requirements.
  - 2. Schedule training with Owner's Representative with at least seven (7) days notice.

END OF SECTION 23 05 14



**SECTION 23 05 29  
HANGERS AND SUPPORTS**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. This Section includes hangers and supports for mechanical systems piping and equipment.

**1.3 SUBMITTALS**

- A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product data for each type of hanger and support.
- C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

**1.4 QUALITY ASSURANCE**

- A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code--Steel."
  - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. Listing and Labeling: Provide hangers and supports that are listed for their intended use.
  - 1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURED UNITS**

- A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.
  - 1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
  - 2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

- B. Thermal-Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

## 2.2 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36, steel plates, shapes, and bars, black and galvanized.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Grout: ASTM C 1107, Grade B, nonshrink, nonmetallic.
  - 1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is nonstaining, noncorrosive, nongaseous and is recommended for both interior and exterior application.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Water: Potable.
  - 4. Packaging: Premixed and factory-packaged.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in the Section specifying the equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments to properly support piping from building structure.
- B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
- C. Install supports with maximum spacings complying with MSS SP-69.
- D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
- E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
- F. Install concrete inserts in new construction prior to placing concrete.
- G. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

- J. Support fire protection systems piping independent of other piping.
- K. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
  - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
  - 2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
  - 3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:
 

THICKNESS NPS (Inches)	LENGTH (Inches)	
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105
  - 4. Pipes 8 Inches and Larger: Include pressure treated wood inserts.
  - 5. Insert Material: Length at least as long as the protective shield.
  - 6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make a smooth bearing surface.
- C. Provide housekeeping pads where indicated on plans.

### 3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### 3.6 ESCUTCHEONS, SLEEVES AND RISER CLAMPS

- A. Contractor shall furnish and install all escutcheons, inserts, thimbles, hangers, etc. required for the proper support and installation of his equipment and piping and he shall cooperate with other trades in locating and placing these items.
- B. Contractor shall furnish and install all piping sleeves required. Sleeves passing through structural members or concrete footings shall be of cast iron or Schedule 40 steel pipe. Sleeves passing through nonstructural walls or floors shall be of 26-gauge galvanized iron. Joints between sleeves and pipes passing through floors shall be made weather tight with plastic materials. Where pipes pass through water proofing membrane, flashing sleeves shall be installed. Sleeves of structural members shall be as detailed on structural plans.
- C. Provide malleable iron split ring hangers with rod supports as specified. Strap hangers or wire will not be accepted. Spacing of hangers shall be as required above by MSS Standards. Maximum spacing shall no case exceed the following: For cast iron pipes 5ft.; for other than soil pipes 10 ft.
- D. Provide galvanized iron shields between hangers and pipe covering.
- E. Provide heavy steel riser clamps on vertical risers at floors to support pipes.
- F. Provide chrome plated brass escutcheons wherever pipes pass through floors, walls or ceilings in exposed or finished areas.
- G. All piping projecting from chases shall be rigidly supported in the wall or chase. Loosely supported piping, fixtures or accessories will not be accepted.

### 3.7 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Division 09 Section "Paints and Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

**SECTION 23 05 53  
MECHANICAL IDENTIFICATION**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Duct labels.
  - 5. Stencils.
  - 6. Valve tags.
  - 7. Warning tags.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

**1.4 COORDINATION**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

**PART 2 - PRODUCTS**

**2.1 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 4. Fasteners: Stainless-steel rivets or self-tapping screws.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
  2. Letter Color: White.
  3. Background Color: Black.
  4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  7. Fasteners: Stainless-steel rivets or self-tapping screws.
  8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

E. Refrigerant Pipe Labels:

1. The pipe identification shall be located at intervals not exceeding 20 feet (6096 mm) on the refrigerant piping or pipe insulation. The minimum height of lettering of the identification label shall be 1/2 inch (12.7 mm). The identification shall indicate equipment served designation, the refrigerant designation, and safety group classification of refrigerant used in the piping system. For Group A2, A3, B2 and B3 refrigerants, the identification shall also include the following statement: "DANGER—Risk of Fire or Explosion. Flammable Refrigerant." For any Group B refrigerant, the identification shall also include the following statement: "DANGER—Toxic Refrigerant."

## 2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  2. Lettering Size: At least 1-1/2 inches high.

## 2.5 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
  1. Stencil Material: Aluminum.
  2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
  3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

## 2.6 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass wire-link or beaded chain; or S-hook.

- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches.
2. Fasteners: Brass grommet and wire .
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels (Excluding refrigerant piping).

- C. Pipe Label Color Schedule (Verify exact color prior to installation):

1. Chilled-Water Piping:
  - a. Background Color: Green.
  - b. Letter Color: White.
2. Heating-Water Piping:
  - a. Background Color: Green.



- b. Letter Color: White.
- 3. Domestic Cold Water Piping:
  - a. Background Color: Green.
  - b. Letter Color: White.
- 4. Domestic Hot Water Piping:
  - a. Background Color: Blue.
  - b. Letter Color: White.
- 5. Steam Piping:
  - a. Background Color: Yellow.
  - b. Letter Color: Black.
- 6. Steam Condensate Piping:
  - a. Background Color: Yellow.
  - b. Letter Color: Black.
- 7. Natural Gas Piping:
  - a. Background Color: Yellow.
  - b. Letter Color: Black.
- 8. Plant Air and Compressed Air Piping:
  - a. Background Color: Blue.
  - b. Letter Color: White.
- 9. Vacuum Piping:
  - a. Background Color: White.
  - b. Letter Color: Black.
- 10. Nitrogen Piping:
  - a. Background Color: Black.
  - b. Letter Color: White.
- 11. Helium Piping:
  - a. Background Color: Blue.
  - b. Letter Color: White.
- 12. Carbon Dioxide Piping:
  - a. Background Color: Grey.
  - b. Letter Color: White.
- 13. Hydrogen Piping:
  - a. Background Color: yellow.
  - b. Letter Color: Black.

### 3.4 DUCT LABEL INSTALLATION

- A. Install plastic-laminated self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
  - 1. Blue: For cold-air supply ducts.
  - 2. Yellow: For hot-air supply ducts.
  - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  - 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

### 3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

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



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 CERTIFICATIONS**

- A. The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications.
- B. TAB contractor shall be an independent third-party firm not associated with the Division 22 or 23 contractor.

**1.3 SCOPE OF WORK**

- A. The balancing, testing, and adjusting of the air conditioning, heating and ventilating systems shall be performed by an independent balancing company possessing calibrated instruments, qualified engineers and skilled technicians to perform all tests. The balancing agency shall be responsible for inspecting, adjusting, balancing, and logging the data on the performance of fans, air handling units, low pressure supply and exhaust ductwork, and heat exchangers. The Mechanical Contractor and the suppliers of the equipment installed shall cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components and shall furnish all labor and material required to calibrate any deficiencies in construction.
- B. This Section specifies the requirements and procedures total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and recording and reporting the results.
- C. Test, adjust, and balance the following mechanical systems:
  - 1. Supply air systems, all pressure range;
  - 2. Fresh Air
  - 3. Exhaust Air
  - 4. Return air systems
  - 5. AHUs
  - 6. Fans
  - 7. Hoods
  - 8. Verify temperature control system operation;
- D. Provide assistance to Division 23 and Division 26 Contractor and project Architect in system commissioning process. Identify all system variances of greater than 10% and make required measurements, adjustments, etc. to bring systems into compliance to satisfaction of project Architect.
- E. THE TEST AND BALANCE CONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING OUT AND REPORTING EACH SEQUENCE OF HEATING, COOLING AND CONTROL INTERLOCK OPERATION FOR THE EQUIPMENT REFERENCED ABOVE.

**1.4 DEFINITIONS**

- A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
  - 1. The balance of air distribution;
  - 2. Adjustment of total system to provide design quantities;
  - 3. Electrical measurement;

4. Verification of performance of all equipment and automatic controls;
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- H. Main: Duct or pipe containing the system's major or entire fluid flow.
- I. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.
- J. Branch main: Duct or pipe serving two or more terminals.
- K. Branch: Duct or pipe serving a single terminal.

#### 1.5 SUBMITTALS

- A. Agency Data:
  1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
- B. Engineer and Technicians Data:
  1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.
- C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
- D. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 01 and Section 230020.
- E. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.
- F. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
  1. Draft reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
  2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports.

3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
  4. General Information and Summary
    - a. Air Systems
    - b. Hydronic Systems
    - c. Temperature Control Systems
    - d. Special Systems
  5. Report Contents: Provide the following minimum information, forms and data:
    - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
    - b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC and NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
  6. Provide electronic (PDF) copies of all documentation included in the Final Report.
- G. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.
- H. At the front of the Report, the TAB Contractor shall provide a summary sheet identifying system operational variances problems, etc. recommended corrective measures that in the opinion of the TAB Contractor should be enacted by the Mechanical Contractor prior to retesting. Submit to project Architect as work progresses with resolution documented for inclusion in final report.

#### 1.6 QUALITY ASSURANCE

- A. Test and Balance Engineer's Qualifications: A Professional Engineer (independent consultant), registered in the State in which the services are to be performed, and having testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.
- B. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

#### 1.7 PROJECT CONDITIONS

- A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

#### 1.8 SEQUENCING AND SCHEDULING

- A. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg F wet bulb temperature of maximum summer design condition, and within 10 deg F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

### PART 2 - PRODUCTS (NOT APPLICABLE)

### PART 3 - EXECUTION

#### 3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

- A. Before operating the system, perform these steps:
  1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.

2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
3. Compare design to installed equipment and field installations.
4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
5. Check filters for cleanliness.
6. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
8. Determine best locations in main and branch ductwork for most accurate duct traverses.
9. Place outlet dampers in the full open position.
10. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
11. Lubricate all motors and bearings.
12. Check fan belt tension.
13. Check fan rotation.

### 3.2 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING

#### A. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean all strainers.
3. Examine hydronic systems and determine if water has been treated and cleaned.
4. Check pump rotation.
5. Clean and set automatic fill valves for required system pressure.
6. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
7. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
8. Set temperature controls so all coils are calling for full flow.
9. Check operation of automatic bypass valves.
10. Check and set operating temperatures of chilled water heat exchangers to design requirements.
11. Lubricate all motors and bearings.
12. Test VAV boxes and hot water/electric heating coils.
13. Test sequencing of all motorized dampers, smoke dampers, etc.

### 3.3 MEASUREMENTS

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.
- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- G. Take all reading with the eye at the level of the indicated value to prevent parallax.
- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- I. Take measurements in the system where best suited to the task.

### 3.4 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
- B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, ductwork, and housings, using materials identical to those removed.
- D. Seal ducts and piping, and test for and repair leaks.
- E. Seal insulation to re-establish integrity of the vapor barrier.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- G. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

### 3.5 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.
- C. Prepare a summary sheet of noted variances in excess of  $\pm 10\%$  of design value. Include all such variances, recommended resolutions and ultimate result in Appendix "A" to TAB Final Report.

### 3.6 DEMONSTRATION

- A. Training:
  - 1. Train the Owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with the Owner's personnel, the information contained in the Operating and Maintenance Data specified in Division 01 and 230020.
  - 2. Schedule training with Owner through the Architect with at least 7 days prior notice.

END OF SECTION 23 05 93





**SECTION 23 07 13  
INSULATION**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. This Section includes:
  - 1. Piping insulation including fittings and valves.
  - 2. Duct insulation (internal lining and external wrapping)
  - 3. Mechanical equipment room walls and ceilings
  - 4. Mechanical equipment insulation.
- C. Cover and insulate all valves, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run and piping system. Install factory molded, pre-cut or field cut and fabricated units (at installer's option) except where specifically noted otherwise.
- D. Maintain the integrity of vapor jackets on all pipe insulation, duct insulation, equipment insulation and protect during construction to prevent puncture or other damage.

**1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:
  - 1. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.
  - 2. Manufacturer's installation recommendations.
  - 3. Material certificates, signed by the manufacturer, certifying that materials as a minimum, comply with specified requirements where laboratory test reports cannot be obtained.
  - 4. Material test reports prepared by a qualified independent testing laboratory. Certify insulation meets specified requirements.

**1.4 QUALITY ASSURANCE**

- A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.
  - 1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
  - 2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

**1.5 SEQUENCING AND SCHEDULING**

- A. Schedule piping and duct insulation application only after the testing of piping and duct systems is complete and accepted.
- B. Schedule insulation application after installation and testing of heat trace tape is complete and accepted.

- C. Schedule insulation of walls and ceiling to correspond with installation of pipe hangers, supports and equipment.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Pipe insulation shall not begin until all work has been tested and found to be tight. All insulation adhesives, sealers, tapes and mastic shall meet the latest NFPA requirements and shall meet 25/50/50 flame spread and smoke developed ratings.
- B. All insulation shall be installed in strict accordance with the manufacturer's recommendations.
- C. All pipe insulation where recommended by the manufacturer shall be banded with aluminum bands, three to a section and with one band on each side of each fitting, valve, etc.
- D. Insulation shall be continuous through walls and ceilings.
- E. All valves, strainers, etc. shall be insulated the same as its adjacent piping and the covering shall extend all the way up to the equipment.
  - 1. USE HIGH DENSITY INSULATION INSERTS AT HANGERS ON ALL PIPING 1-1/2" AND ABOVE TO PREVENT CRUSHING OF INSULATION.

### 2.2 THERMAL INSULATION

- A. After all work has been tested and approved, insulate as follows:
  - 1. INSULATION SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND INSTRUCTIONS.

### 2.3 DOMESTIC WATER PIPING

- A. Cover all domestic cold and hot water lines and hot water return lines above slab with 1" thick, high density fiberglass insulation with Universal Fire-Retardant Jacket, Owens/Corning "25 ASJ/SSL", Knauf ASJ-SSL, or equal. All laps are to be sealed and stapled in place. Fittings are to be mitered segments of insulation held in place with white vapor barrier tape for concealed areas and Zeston 25/50 PVC, Knauf 25/50 rated PVC, pre-molded insulated fitting covers in exposed areas.
- B. Domestic cold and hot water lines (2 -1/2" and above) shall be insulated with 1-1/2" thick fiberglass with jacket.
- C. All water lines exposed in mechanical rooms shall be covered with 0.030 PVC jacket with solvent welded seams and joints.
- D. All water lines on the outside of the building exposed to the weather shall be covered with 0.160 smooth aluminum jacket and elbows.
- E. Domestic cold and hot water lines run below slab within building shall be insulated with 3/4" thick closed cell tube insulation. Apply two (2) coats of mastic on insulation.

### 2.4 CONDENSATE DRAIN PIPING

- A. Insulate with 1/2" Aerotube or Armaflex pipe insulation applied in accordance with manufacturer's recommendations and instructions.

### 2.5 WASTE LINE P-TRAPS

- A. P-traps receiving HVAC condensate (exposed to weather or above ceilings) shall be insulated with 2.33" thick 3/4 # density fiberglass ductwrap insulation with aluminum foil vapor barrier. Insulation shall be sealed at all seams and joints.

## 2.6 LAVATORY P-TRAP & SUPPLY LINES

- A. Unless specified otherwise on drawings, insulate p-trap, tailpiece and water supplies on handicapped lavatories with white, Truebro Model 102 Handi Lav-Guard, Pro-Wrap A.D.A. lavatory insulation kit, or approved equivalent insulating system to meet A.D.A. Requirements. Provide accessories for offset tailpiece as required.

## 2.7 REFRIGERANT LINES

- A. Insulate with 3/4" closed cell, tube insulation, Aerotube, Armaflex or equivalent. All insulation shall be sealed to not allow for any air to enter the insulation. Joints shall be glued and sealed per the insulation manufacturer's recommendation. All insulation located outdoors shall be jacketed with aluminum jacket or apply two coats of weatherproof mastic. Contractor shall install refrigerant lines below grade in watertight PVC sleeve in accordance with manufacturer's recommendations.
- B. All copper refrigerant lines shall be separated from dissimilar metals at all support points.

## 2.8 AIR HANDLING ROOM WALLS

- A. Furnish and install over entire areas of walls of air handling rooms containing a/c units a 1" thick Manville Linacoustic or equal acoustical type duct insulation 3# density, applied over Slick-Klips 12" on center. Stick-Klips shall be applied to wall with Miracle Adhesive. Acoustical material shall be applied over Stick-Klips with duct liner adhesive tape EC-104 spotted between pins. Stick-Klips with factor applied adhesive will not be acceptable.

## 2.9 AHU ROOMS

- A. Furnish and install over entire areas of walls, doors and ceilings of mechanical rooms sound absorbing 2" thick, 3# density semi-rigid fiberglass board. The board shall be faced with reinforced mylar polyester film laminate composed of a mylar face, with fiberglass scrim, laminated with a flame-retardant adhesive. The fiberglass board and the facing shall meet flame speed of not greater than 25, and a smoke developed rating of not greater than 50. This board shall be equal to Pelican Board Type RM as manufactured by Reilly-Benton, Peabody Noise Control Type S4 or equal. Insulation shall be installed by impaling on stick-pins with a suitable adhesive (no self-stick pins may be used). After material is impaled on pins, the tip of the pin shall be covered with a white dome-cap washer. All joints, corners, and exposed edges shall be covered with the facing material. Material shall be applied over curved walls and roof at AHU Rooms.

## 2.10 HVAC DUCTWORK INSULATION:

- A. Supply, return, transfer, fresh air and exhaust ductwork shall be wrapped on outside with 3/4# density fiberglass insulation with aluminum foil vapor barrier with a minimum R-Value of R-6 (unless stated otherwise on mechanical drawings). Insulation shall be taped at all joints and installed per the manufacturer's recommendations.
- B. Refer to air distribution section of mechanical specifications for duct insulation supplied by the sheet metal sub-contractor.
- C. Transfer ductwork across walls shall be internally lined with 1" thick acoustical insulation.

## 2.11 HVAC FLEX-CONNECTIONS:

- A. Shall be wrapped on outside with 3/4 # density fiberglass insulation with aluminum foil vapor barrier with a minimum R-value of R-6. Insulation shall be taped at all joints and installed per the manufacturer's recommendations.

## 2.12 KITCHEN HOOD

- A. Shall be rated for 0" clearance or shall be installed in accordance with NFPA 96.

## 2.13 KITCHEN HOOD EXHAUST DUCTWORK

- A. Ductwork exposed to combustible construction materials shall be enclosed with 3" thick PABCO Super Firetemp M ductwrap system of inorganic mineral fiberboard, Super Calstik applied at all joints, fastened with

drywall screws (length twice insulation thickness) at 8" O.C. at joints where sections meet at right angles or Thermal Ceramics Firemaster duct wrap system of 3" grease duct enclosure, 1/2" stainless steel bands, clips, insulation pins and speed clips. Duct wrap systems shall be installed in accordance with manufacturer's recommendations to meet latest N.F.P.A requirements for 0" clearance to combustibles.

2.14 KITCHEN HOOD SUPPLY DUCTWORK

- A. Wrap with 3/4 # density fiberglass insulation with aluminum foil vapor barrier with a minimum R-value of R-6. Insulation shall be taped at all joints and installed per manufacturer's recommendations.

2.15 HOT WATER EXPANSION TANKS

- A. Shall be insulated with 1/2" aerotube, armaflex or equal sheets adhered to tank with contact adhesive and sealed at all joints. Finish with white vapor barrier mastic and glassfab BF30-35, insulacoustic 501-C or equal.

2.16 CALIBRATED BALANCING VALVES

- A. Insulate calibrated balancing valves with molded insulated furnished with the unit and provide strap bands for access.

2.17 INSULATION THROUGH HANGERS AND SLEEVES

- A. The insulation shall be continuous through pipe hangers and pipe sleeves. At hangers where the pipe is supported by insulation, provide a galvanized iron protection shield. Provide pipes 2-inch i.p.s. and larger in insulation inserts at points of hanger supports. The inserts shall be of calcium silicate, cellular glass, prestressed molded glass fiber of minimum 13-pound density, or other approval material of the same thickness as adjacent insulation and not less than 13-pound density. The inserts shall have sufficient compression strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation. Inserts shall be 180 degrees and not less than the length of the protection shield. Vapor barrier facing of the insert shall be the same as the facing on the adjacent insulation. Where copper clad hangers are used on domestic copper pipe, insulation may cover pipe and hanger. Provide 18-gauge metal saddles between all hangers and insulation.

END OF SECTION 23 07 13

**SECTION 23 23 00**  
**REFRIGERANT PIPING AND SPECIALTIES**



**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check valves.
- G. Pressure relief valves.
- H. Filter-driers.
- I. Solenoid valves.
- J. Expansion valves.
- K. Receivers.
- L. Flexible connections.

**1.2 REFERENCES**

- A. ARI 495 - Refrigerant Liquid Receivers.
- B. ARI 710 - Liquid Line Dryers.
- C. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers
- D. ARI 750 - Thermostatic Refrigerant Expansion Valves.
- E. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants.
- F. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- G. ASHRAE 34 - Number Designation of Refrigerants.
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- I. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes.
- J. ASME B31.5 - Refrigeration Piping.
- K. ASME B31.9 - Building Services Piping.
- L. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- M. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- N. AWS A5.8 - Brazing Filler Metal.

- O. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- P. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- Q. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

### 1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with ASTM B31.5 unless indicated otherwise.
- C. Liquid Indicators:
  - 1. Use line size liquid indicators in main liquid line leaving condenser.
  - 2. If receiver is provided, install in liquid line leaving receiver.
  - 3. Use line size on leaving side of liquid solenoid valves.
- D. Valves
  - 1. Use service valves on suction and discharge of compressors.
  - 2. Use gage taps at compressor inlet and outlet.
  - 3. Use gage taps at hot gas bypass regulators, inlet and outlet.
  - 4. Use check valves on compressor discharge.
  - 5. Use check valves on condenser liquid lines on multiple condenser systems.
- E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- F. Strainers:
  - 1. Use line size strainer upstream of each automatic valve.
  - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
  - 3. Use shut-off valve on each side of strainer.
  - 4. Pressure Relief Valves: Use on ASME receivers [and pipe to outdoors].
- G. Permanent Filter-Driers:
  - 1. Use in low temperature systems.
  - 2. Use in systems utilizing hermetic compressors.
  - 3. Use filter-driers for each solenoid valve.
- H. Solenoid Valves:
  - 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
  - 2. Use in liquid line of single or multiple evaporator systems.
  - 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- I. Receivers:
  - 1. Use on systems 5 tons and larger, sized to accommodate pump down charge.
  - 2. Use on systems with long piping runs.
  - 3. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

### 1.4 SUBMITTALS

- A. Submit under provisions of Section 23.
- 1.5 PROJECT RECORD DOCUMENTS
  - A. Submit under provisions of Section 23.
  - B. Record exact locations of equipment and refrigeration accessories on record drawings.
- 1.6 OPERATION AND MAINTENANCE DATA
  - A. Submit under provisions of Section 23.
  - B. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.
- 1.7 QUALIFICATIONS
  - A. Installer: Company specializing in performing the work of this section.
- 1.8 REGULATORY REQUIREMENTS
  - A. Conform to ASME B31.9 for installation of piping system.
  - B. Welding Materials and Procedures: Conform to ASME SEC 9.
  - C. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.
- 1.9 DELIVERY, STORAGE, AND HANDLING
  - A. Deliver, store, protect and handle products to site under provisions of Section 01.
  - B. Deliver and store piping and specialties in shipping containers with labeling in place.
  - C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- 1.10 MAINTENANCE MATERIALS
  - A. Provide maintenance materials under provisions of Section 01.
  - B. Provide containers each with refrigerant.

## PART 2 - PRODUCTS

- 2.1 PIPING
  - A. Copper Tubing: ASTM B280, Type "K", ACR hard drawn to be used between VRF outdoor condensing units and branch controllers.
  - B. Copper Tubing: ASTM B280, pre-insulated Type "L", ACR soft copper with brazed joints to be used between VRF branch controllers and VRF cassettes or air handlers.
  - C. Fittings: ASME B16.22 wrought copper.
  - D. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C). Brazing shall only occur once piping system has been purged and flowing dry nitrogen to prevent internal oxidation.
  - E. Pipe Supports and Anchors:
    - 1. Conform to ASME B31.5.

2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 Inches (75 mm): Cast iron hook.
6. Vertical Support: Steel riser clamp.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
9. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
10. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## 2.2 REFRIGERANT

### A. Refrigerant: ASHRAE 34;

1. R-410A

## 2.3 MOISTURE AND LIQUID INDICATORS

- ### A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum working pressure of 500 psig and maximum temperature of 200 degrees F.

## 2.4 VALVES

### A. Ball Valves:

1. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal lockable cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 300 degrees F.

### B. Service Valves:

1. Forged brass body with copper stubs, brass lockable caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig (3450 kPa).

## 2.5 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; for maximum working pressure of 430 psig (2960 kPa).

## 2.6 CHECK VALVES

### A. Globe Type:

1. 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; for maximum working pressure of 500 psig and maximum temperature of 300 degrees F (149 degrees C).

## 2.7 PRESSURE REGULATORS

- ### A. Brass body, stainless steel diaphragm, direct acting adjustable over 0 to 80 psig (0 to 550 kPa) range, for maximum working pressure of 450 psig.

## 2.8 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 450 psig setting; selected to ASHRAE 15.



## 2.9 FILTER-DRIERS

### A. Permanent Straight Through Type:

1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 500 psig.
2. Rating: ARI 710 moisture rating.

## 2.10 SOLENOID VALVES

- ### A.
- Valve: ARI 760, pilot operated, copper or brass [or steel] body and internal parts, synthetic seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem shall permit manual operation in case of coil failure.

## 2.11 EXPANSION VALVES

- ### A.
- Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, non-adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb.
- ### B.
- 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 (6 degrees C) superheat. Select to avoid being undersized at full load and excessively oversized at part load.

## 2.12 RECEIVERS

### A. Internal Diameter 6 inch (150 mm) and Smaller:

1. ARI 495, UL listed, steel, brazed; 400 psig maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

### B. Internal Diameter Over 6 inch (150 mm):

1. ARI 495, welded steel, tested and stamped in accordance with ASME SEC 8D; 400 psig with tappings for liquid inlet and outlet valves, pressure relief valve.

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

### 3.2 INSTALLATION

- #### A.
- Install refrigeration specialties in accordance with manufacturer's instructions.
- #### B.
- Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- #### C.
- Install piping to conserve building space and not interfere with use of space.
- #### D.
- Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- #### E.
- Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- #### F.
- Inserts:

1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut [above] [flush with top of] [recessed into and grouted flush with slab].

G. Pipe Hangers and Supports:

1. Install in accordance with ASTM B31.5.
2. Support horizontal piping as scheduled.
3. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Provide copper plated hangers and supports for copper piping.
8. Arrange 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.
9. Provide clearance for installation of insulation and access to valves and fittings.
10. Provide access to concealed valves and fittings.
11. Flood piping system with nitrogen when brazing.
12. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
13. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09900.
14. Insulate piping; refer to Section 15001 and Section 15200.
15. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
16. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
17. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
18. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01400.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to 200 psig (1470 kPa).

3.4 SCHEDULES

Pipe Hanger Spacing

PIPE SIZE Inches (mm)	MAX. HANGER SPACING Feet (m)	DIAMETER Inches (mm)
1/2 to 1-1/4 (12 to 32)	6.5 (2)	3/8 (9)
1-1/2 to 2 (38 to 50)	10 (3)	3/8 (9)
2-1/2 to 3 (62 to 75)	10 (3)	1/2 (13)
4 to 6 (100 to 150)	10 (3)	5/8 (15)
8 to 12 (100 to 150)	10 (3)	5/8 (22)

END OF SECTION 23 23 00



**SECTION 23 31 13  
METAL DUCTS**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

**A. Section Includes:**

- 1. Single-wall rectangular ducts and fittings.
- 2. Single-wall round ducts and fittings.
- 3. Kitchen Hood ducts.
- 4. Sheet metal materials.
- 5. Duct liner.
- 6. Sealants and gaskets.
- 7. Hangers and supports.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical System
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

**1.4 SUBMITTALS**

**A. Product Data: For each type of the following products:**

- 1. Liners and adhesives.
- 2. Sealants and gaskets.

**B. Shop Drawings:**

- 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
- 2. Factory- and shop-fabricated ducts and fittings.
- 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
- 4. Elevation of top of ducts.
- 5. Dimensions of main duct runs from building grid lines.
- 6. Fittings.
- 7. Reinforcement and spacing.
- 8. Seam and joint construction.
- 9. Penetrations through fire-rated and other partitions.
- 10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including but are not limited to the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.
  - g. F/A devices, wi-fi antennas, etc.

E. Welding certificates.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Lindab Inc.
    - b. McGill AirFlow, LLC.
    - c. SEMCO Incorporated.
    - d. Sheet Metal Connectors, Inc.
    - e. Eastern Sheet Metal, Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
  - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. All round ductwork shall comply with latest SMACNA standards. All round ductwork 4 in. – 14 in. shall be a minimum 26 ga. steel.

## 2.3 KITCHEN HOOD DUCTS

- A. Ducts shall be constructed in accordance with NFPA 96 construction standards.
- B. All ductwork shall be furnished and shall be UL listed grease duct according to the manufacturer's listing, conforming to NFPA 96 and built to lengths required. Exhaust duct connecting to collars shall be the heat

expansion type, confirming to NFPA 96 recommendations. Exhaust duct to be minimum 14-gauge black iron or carbon steel and supply duct minimum 18-gauge carbon steel. All exhaust duct seams and joints shall be made liquid-tight with a continuous external weld.

- C. Ductwork shall be designed to connect directly to hood and roof package when system is installed per manufacturer's recommendations. All sections of the duct shall be constructed and installed without forming dips and traps and shall slope not less than 1 inch per foot toward either the hood or an approved residue trap.

## 2.4 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized. (Paint Grip)
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.5 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
    - a. CertainTeed Corporation; Insulation Group.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  - 3. Maximum Thermal Conductivity:
    - a. Type I, Flexible: 3 lbs. Density / 1 1/2" thick.
    - b. Type II, Rigid: 3 lbs. Density / 1 1/2" thick.
  - 4. Solvent -Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Insulation Pins and Washers:
  - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
  - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.



2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
  - a. Fan discharges.
  - b. Intervals of lined duct preceding unlined duct.
  - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
  - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Rolled Mastic Sealant
  1. Pressure-Sensitive rolled mastic sealant comprised of a foil facer with butyl adhesive
  2. Rolled Mastic Sealant: 2-inch minimum width.
  3. Rolled Mastic Sealant: 17-mil thickness; minimum
  4. Water Resistant
  5. Mold and Mildew Resistant
  6. Maximum Pressure Class: 16-inch W.C., positive/negative
  7. Service: Indoor and Outdoor
  8. Service Temperature: Minus 20 F to 200 F
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum
  10. VOC: 0 g/l, EPA Standard Method 24
  11. UL 181B-FX
- C. Water-Based Joint and Seam Sealant:
  1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.
  3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 16-inch wg, positive and negative.
  8. Service: Indoor or outdoor.
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
  10. UL-181 Listed

11. UL 2818, Green Guard Compliance

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 16-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
13. UL-181 Listed

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

### PART 3 - EXECUTION

#### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 4. Unconditioned Space, Exhaust Ducts: Seal Class C.
  - 5. Unconditioned Space, Return-Air Ducts: Seal Class B.
  - 6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
  - 7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
  - 8. Conditioned Space, Exhaust Ducts: Seal Class B.
  - 9. Conditioned Space, Return-Air Ducts: Seal Class C.
- C. Seal all duct penetrations through interior and exterior building walls per 07 92 00 Joint Sealants and Section 09 29 00: 3.5 for a complete penetration seal to the satisfaction of engineer.

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

- B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Test the following systems:
    - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    - b. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  4. Test for leaks before applying external insulation.
  5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
  2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.8 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Duct Accessories" for access panels and doors.
  2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
  2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  4. Coils and related components.
  5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  6. Supply-air ducts, dampers, actuators, and turning vanes.
  7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within new duct systems and remove contaminants from building.
  2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

### 3.9 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

### 3.10 DUCT SCHEDULE

#### A. Supply Ducts:

1. Ducts Connected Downstream of Fan Coil Units, and Terminal Units:
  - a. Pressure Class: Positive 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 12
2. Ducts Connected to Variable-Air-Volume Air-Handling Units and Inlets of Terminal Units:
  - a. Pressure Class: Positive 4-inch wg
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3
3. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive 2-inch wg.
  - b. Minimum SMACNA Seal Class: A
  - c. SMACNA Leakage Class for Rectangular: 3.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3.

#### B. Return Ducts:

1. Ducts Connected to Air-Handling Units
  - a. Pressure Class: Positive or negative 4-inch wg.
  - b. Minimum SMACNA Seal Class: A
  - c. SMACNA Leakage Class for Rectangular: 6
  - d. SMACNA Leakage Class for Round and Flat Oval: 6
2. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative 2-inch wg>.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3.
  - d. SMACNA Leakage Class for Round and Flat Oval: 3.

#### C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - a. Pressure Class: Negative 1-inch wg.
  - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.
2. Ducts Connected to Equipment Not Listed Above:
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: 6.

- d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
  - 1. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 6
    - d. SMACNA Leakage Class for Round and Flat Oval: 6.
  - 2. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A
    - c. SMACNA Leakage Class for Rectangular: 6.
    - d. SMACNA Leakage Class for Round and Flat Oval: 6
- E. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel
- F. Elbow Configuration:
  - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
    - a. Velocity 700 fpm or Lower:
      - i. Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      - ii. Mitered Type RE 4 without vanes.
    - b. Velocity 700 to 1500 fpm:
      - i. Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      - ii. Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      - iii. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
    - c. Velocity 1500 fpm or Higher:
      - i. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      - ii. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      - iii. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
    - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
    - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      - i. Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      - ii. Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      - iii. Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      - iv. Radius-to Diameter Ratio: 1.5.
    - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
    - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

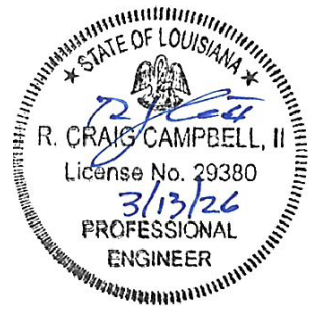
J. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm: Conical tap.
  - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13



**SECTION 23 33 00  
DUCT ACCESSORIES**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. This Section includes the following:
  - 1. Backdraft dampers.
  - 2. Manual volume control dampers.
  - 3. Motorized Dampers.
  - 4. Spin Collars.
  - 5. Fire Dampers.
  - 6. Smoke Dampers.
  - 7. Turning vanes.
  - 8. Duct-mounted access doors and panels.
  - 9. Flexible connectors.
  - 10. Flexible ducts.
  - 11. Accessories hardware.

**1.3 SUBMITTALS**

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
- B. Product data including details for materials, dimensions of individual components, profiles, and finishes for the following items:
  - 1. Backdraft dampers.
  - 2. Manual volume control dampers.
  - 3. Motorized Dampers.
  - 4. Spin Collars.
  - 5. Fire Dampers.
  - 6. Smoke Dampers.
  - 7. Turning vanes.
  - 8. Duct-mounted access doors and panels.
  - 9. Flexible connectors.
  - 10. Flexible ducts.
  - 11. Accessories hardware.
- C. Shop drawings from manufacturer detailing assemblies. Include dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail the following:
  - 1. Special fittings, volume control damper installation (both manual and automatic), and transformers details.
  - 2. Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installations.
- D. Product Certification: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static pressure loss, and dimensions and weights.

#### 1.4 QUALITY ASSURANCE

A. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

#### PART 2 - PRODUCTS

##### 2.1 BACKDRAFT DAMPERS

- A. Description: Suitable for horizontal or vertical installation.
- B. Frame: 0.063-inch-thick 6063T extruded aluminum.
- C. Blades: 0.025-inch-thick roll-formed aluminum.
- D. Blades: 0.050-inch-thick 6063T extruded aluminum.
- E. Blade Seals: Vinyl.
- F. Blade Axles: Nonferrous.
- G. Tie Bars and Brackets: Aluminum.
- H. Return Spring: Adjustable tension.
- I. Wing-Nut Operator: Galvanized steel, with 1/4-inch galvanized-steel rod.
- J. Adjustable Pressure Controls.
- K. Dampers to be Greenheck EM-30, Ruskin BD6, Pottorff BD-150, or approved equal.

##### 2.2 MANUAL VOLUME CONTROL DAMPERS

- A. General: Provide factory-fabricated volume-control dampers, complete with required hardware and accessories. Stiffen damper blades to provide stability under operating conditions. Provide locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class. Provide end bearings or other seals for ducts with pressure classifications of 3 inches or higher. Extend axles full length of damper blades. Provide bearings at both ends of operating shaft.
- B. Standard Volume Control Dampers: Multiple or single-blade, parallel or opposed-blade design as indicated, standard-leakage rating, with linkage outside of air stream, and suitable for horizontal or vertical applications. Greenheck MDB-15, Ruskin MD-15, Pottorff CD-10 & MD-41, or approved equal.
- C. Provide damper stand off bracket to accommodate duct insulation.

##### 2.3 MOTORIZED DAMPERS

- A. Mechanical Contractor shall furnish and install motorized dampers as indicated on mechanical and architectural drawings. Damper shall be opposed blade motorized type equivalent to Greenheck Model VCD-23, Ruskin CD36/OB, Pottorff CD-41, or equal with actuators. Motorized dampers shall be operated by 120/1/60 electric actuator (low sound) as indicated on plans. Damper shall be complete with outboard support bearing, blade, and jamb seals. Dampers shall be low - leakage type. Dampers shall go to closed position when units are off unless otherwise noted.

## 2.4 SPIN COLLARS

- A. All round take-offs to round branch duct shall be made with 26-gauge spin-type collars with 26-gauge balancing dampers. These spin-collars shall be as manufactured by Flexmaster Model FLD, Dace MSD, or approved equivalent.
- B. The mounting groove shall be die-formed to assure constant fit control. Balancing dampers shall be factory-installed with spring loaded, retractable bearings and a positive locking wing-nut for easy adjustment.
- C. Provide damper stand off bracket to accommodate duct insulation.

## 2.5 FIRE DAMPERS

- A. General: UL labeled according to UL Standard 555 "Standard for Fire Dampers."
- B. Fire Rating: 1-1/2 or 3 hours, as indicated on Contract Drawings.
- C. Frame: Type B; fabricated with roll-formed, 22-gage, galvanized-steel; with mitered and interlocking corners.
- D. Style: Dynamic
- E. Mounting Sleeve: Factory-installed galvanized steel.
  - 1. Minimum Thickness: 16 ga thick as indicated, and length to suit application.
  - 2. Factory installed sleeve shall be constructed of gauges as dictated by the manufacturers UL Listing.
  - 3. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of the wall or floor, and thickness of damper frame meets sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 22-gage galvanized steel (or as required by UL Listing). In place of interlocking blades, provide full-length, 21-gage, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include a blade lock and stainless steel negator closure spring.
- I. Fusible Link: Replaceable, 212 deg F rated.
- J. Dampers shall be 100% free area.
- K. Dampers shall be Ruskin DIB Series, Greenheck DFD Series, or equal.

## 2.6 SMOKE DAMPERS

- A. General: UL-labeled according to UL Standard 555S, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems." Combination fire and smoke dampers shall also be UL-labeled for 1-1/2-hour rating according to UL Standard 555 "Standard for Fire Dampers." Refer to Section 230900 "Building Automation System" for additional requirements.
- B. Damper shall bear a Class 1 Leakage rating.
- C. Fusible Link: Replaceable, 212 deg F rated.
- D. Frame and Blades: 16-gage galvanized steel (or as required by UL listing).
- E. Mounting Sleeve: Factory-installed, 18-gage galvanized steel (or as required by UL listing), length to suit wall or floor application.
- F. Actuators are to be 120 volt and provided by the damper manufacturer and be UL tested with the damper.
- G. Step-Down Transformers: Refer to electrical plans for transformer required to transform to 120V, single phase which comply with UL, FM NFPA Requirements for smoke control systems.

- H. Smoke Dampers shall include factory supplied and mounted damper test switch.
- I. Dampers shall be Ruskin SD37 or Greenheck SMD-20, Pottorff SD-141, or approved equal.

## 2.7 TURNING VANES

- A. Fabricate turning vanes according to SMACNA HVAC Duct Construction Standards, Figures 4-3.
- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide, curved blades set at 3/4 inch) on center, support with bars perpendicular to blades set at 2 inches on center, and set into side strips suitable for mounting in ducts.

## 2.8 DUCT-MOUNTED ACCESS DOORS AND PANELS

- A. General: Provide construction and airtightness suitable for duct pressure class.
- B. Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized sheet metal construction with insulation fill and thickness, number of hinges and locks as indicated for duct pressure class. Provide vision panel where indicated. Provide 1-inch by 1-inch butt hinge or piano hinge and cam latches.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.
- E. Insulation: 1-inch- thick fiber glass or polystyrene foam board.
- F. Access doors shall be Ruskin Model ADH-22, Kees ADH, Pottorff HAD, or approved equal.
- G. Access doors for oval and round ducts shall be constructed of 20 ga steel with neoprene gasket and hand knobs for access. Access doors shall be Ruskin Model ADR/ADF, Greenheck RAD, or approved equal.

## 2.9 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.
- B. Standard Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.

## 2.10 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1.
- B. Flexible Ducts – Insulated (2.33", R-6): Factory-fabricated, insulated, round duct, with an outer aluminum jacket, glass fiber insulation around a continuous inner liner.
  - 1. Reinforcement: Steel-wire helix encapsulated in the inner liner.
  - 2. Outer Jacket: Glass-reinforced, silver mylar with a continuous hanging tab, integral fiber glass tape, and nylon hanging cord.
  - 3. Outer Jacket: Polyethylene film.
  - 4. Inner Liner: Polyethylene film for low pressure, woven glass fiber for high pressure.
  - 5. Medium pressure duct rated at 6" static pressure.
  - 6. Manufacturer: Thermaflex or approved equivalent.

## 2.11 ACCESSORIES HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pilot tube and other testing instruments and provide in length to suit duct insulation thickness.

- B. Splitter Damper Accessories: Zinc-plated damper blade bracket, 1/4-inch, zinc-plated operating rod, and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches to suit duct size.
- D. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.
- E. Provide all necessary transformers, electrical components suitable for each system installation including duct damper controllers, fire dampers and smoke dampers.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of duct accessories. Do not proceed with installation until unsatisfactory conditions are corrected.

#### 3.2 INSTALLATION

- A. Install duct accessories according to manufacturer's installation instructions and applicable portions of details of construction as shown in SMACNA standards.
- B. Install volume control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.
- C. Provide test holes at fan inlet and outlet and elsewhere as indicated.
- D. Install fire and smoke dampers according to the manufacturer's UL-approved printed instructions.
- E. Install fusible links in fire dampers.
- F. Label access doors for fire dampers indicating damper type (Fire Damper, Fire Smoke Damper, Smoke Damper).

#### 3.3 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 33 00



**SECTION 23 34 23**  
**HVAC POWER VENTILATORS**



**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. Section Includes:
1. Ceiling-mounted fans.
  2. In-line cabinet fans.
  3. Centrifugal inline fans.
  4. Centrifugal roof downblast fans.
  5. Centrifugal roof upblast fans.
  6. Centrifugal roof kitchen hood ventilator.
  7. Centrifugal sidewall fans.
  8. Sidewall propeller fans.
  9. Upblast propeller roof exhaust fans.
  10. Axial roof fans.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
  2. Rated capacities, operating characteristics, and furnished specialties and accessories.
  3. Certified fan performance curves with system operating conditions indicated.
  4. Certified fan sound-power ratings.
  5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  6. Material thickness and finishes, including color charts.
  7. Dampers, including housings, linkages, and operators.
  8. Prefabricated roof curbs.
  9. Fan speed controllers.
- B. Shop Drawings:
1. Include plans, elevations, sections, and attachment details.
  2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Subject to compliance with requirements, provide products by one of the following:
1. Loren Cook.
  2. GREENHECK.
  3. ACME
  4. Loren Cook Company.

5. PennBarry.
6. Twin City.

## 2.2 CEILING-MOUNTED FANS

- A. Housing: Steel, lined with acoustical insulation.
- B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.
- C. Back-draft damper: Integral.
- D. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
  1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
  3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
  4. Motion Sensor: Motion detector with adjustable shutoff timer.
  5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
  6. Filter: Washable aluminum to fit between fan and grille.
  7. Isolation: Rubber-in-shear vibration isolators.
  8. Manufacturer's standard roof jack or wall cap, and transition fittings.

## 2.3 IN-LINE CABINET FANS

- A. Description: Square in-line centrifugal fans.
- B. Housing:
  1. Housing Material: Reinforced steel.
  2. Housing Coating: Hot-dip galvanized.
  3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream; factory wired to disconnect switch located on outside of fan housing.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance quality and vibration levels for fans.
- F. Motor Enclosure: Open, dripproof type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be provided at the scheduled voltage.
- G. Accessories:
  1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
  2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  3. Companion Flanges: For inlet and outlet duct connections.
  4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
  5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.



6. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

## 2.4 CENTRIFUGAL IN-LINE FANS

- A. Description: Square in-line centrifugal fans.
- B. Housing:
  1. Housing Material: Reinforced steel.
  2. Housing Coating: Hot-dip galvanized.
  3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.
- F. Motor Enclosure: Totally enclosed, fan cooled NEMA Design B motor with Class B insulation. Motor shall be rated for continuous duty and furnished at the scheduled voltage and phase.
- G. Accessories:
  1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
  2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  3. Companion Flanges: For inlet and outlet duct connections.
  4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
  5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
  6. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

## 2.5 CENTRIFUGAL ROOF DOWNBLAST FANS

- A. Housing: Downblast; removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. Belt Drives:
  1. Resiliently mounted to housing.
  2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
  4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
  6. Fan and motor isolated from exhaust airstream.
- D. Accessories:
  1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
  3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
  5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
  6. Spark-resistant, all-aluminum wheel construction.
  7. Mounting Pedestal: Galvanized steel with removable access panel.
- E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Self-flashing without a cant strip, with mounting flange. Manufactured to accommodate roof slope.
  2. Overall Height: 18 inches.
  3. Sound Curb: Curb with sound-absorbing insulation.
  4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
  5. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares.
  6. Pitch Mounting: Manufacture curb for roof slope.
  7. Metal Liner: Galvanized steel.

## 2.6 CENTRIFUGAL ROOF UPBLAST FANS

- A. Configuration: Centrifugal roof upblast ventilator.
- B. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt Drives:
1. Resiliently mounted to housing.
  2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
  4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
  6. Fan and motor isolated from exhaust airstream.
- E. Accessories:
1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
  3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
  5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
  6. Spark-resistant, all-aluminum wheel construction.
- F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange. Manufactured to accommodate roof slope.

## 2.7 CENTRIFUGAL ROOF KITCHEN HOOD VENTILATOR

- A. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
  1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
  2. Provide grease collector.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. Belt Drives:
  1. Resiliently mounted to housing.
  2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
  4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
  6. Fan and motor isolated from exhaust airstream.
- D. Accessories:
  1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
  3. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
  4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
  5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
  6. Spark-resistant, all-aluminum wheel construction.
  7. Mounting Pedestal: Galvanized steel with removable access panel.
  8. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.
- E. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.
  1. Configuration: Self-flashing without a cant strip, with mounting flange manufactured to accommodate roof slope.
  2. Overall Height: 18 inches.
  3. Hinged sub-base to provide access to damper or as cleanout for grease applications.
  4. Pitch Mounting: Manufacture curb for roof slope.
  5. Metal Liner: Galvanized steel.
  6. Mounting Pedestal: Galvanized steel with removable access panel.
  7. Vented Curb: For kitchen exhaust; 12-inch-high galvanized steel; unlined, with louvered vents in vertical sides.
  8. NFPA 96 code requirements for commercial cooking operations.
  9. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.

## 2.8 CENTRIFUGAL SIDEWALL FANS

- A. Configuration: Centrifugal sidewall ventilator.

- B. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt Drives:
  - 1. Resiliently mounted to housing.
  - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
  - 4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  - 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
  - 6. Fan and motor isolated from exhaust airstream.
- E. Accessories:
  - 1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
  - 3. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
  - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
  - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
  - 6. Spark-resistant, all-aluminum wheel construction.
  - 7. Wall Mount Adapter: Attach wall-mounted fan to wall.

## 2.9 SIDEWALL PROPELLER FANS

- A. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.
- B. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- C. Fan Drive:
  - 1. Belt drive.
  - 2. Resiliently mounted to housing.
  - 3. Statically and dynamically balanced.
  - 4. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
  - 5. Extend grease fitting to accessible location outside of unit.
  - 6. Service Factor Based on Fan Motor Size: 1.4.
  - 7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  - 8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
    - a. Ball-Bearing Rating Life: ABMA 9, L(50) of 200,000 hours.
  - 9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
  - 10. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
  - 11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  - 12. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- D. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.

## 2.10 UPBLAST PROPELLER ROOF EXHAUST FANS

- A. Configuration: Upblast propeller ventilator.
- B. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.
  1. Damper Rods: Steel with bronze bearings.
  2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades; sparkproof construction.
- D. Belt Drives:
  1. Resiliently mounted to housing.
  2. Weatherproof housing of same material as fan housing.
  3. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  4. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
  5. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  6. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
  7. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.
- E. Accessories:
  1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
  2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  3. Inspection Door: Hinged.
  4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
  5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
  6. Extended Lubrication Lines.
- F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

## 2.11 AXIAL ROOF VENTILATORS

1. Configuration: Self-flashing without a cant strip, with mounting flange.
- A. Housing: Heavy-gauge, removable, spun-aluminum dome top and outlet baffle; square, one-piece, hinged, aluminum base.
- B. Fan Wheel: Aluminum hub and blades.
- C. Belt Drives:
  1. Resiliently mounted to housing.

2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.

D. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Stack hood with built-in backdraft dampers.
6. Extended lubrication lines.

E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 18 inches.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares.

## 2.12 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

## 2.13 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF HVAC POWER VENTILATORS

- A. Install power ventilators level and plumb.
- B. Secure roof-mounted fans to roof curbs with zinc-plated hardware.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 1 inch.
- E. Install units with clearances for service and maintenance.
- F. Label units with engraved aluminum nameplate. Nameplate shall include the make, model, date of installation, design CFM and static pressure.
- G. For fans installed on metal roofs, coordinate roof curb with the shape profiles of the roof panels. Provide custom color prefinished galvalume exterior cladding on the exterior or the roof curb. Coordinate color of the custom-colored cladding with the Architect.

### 3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

### 3.3 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

### 3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

### 3.5 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

### 3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain ventilator fans.

END OF SECTION 23 34 23





**SECTION 23 37 13**  
**DIFFUSERS, REGISTERS, AND GRILLES**



**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

**1.2 SCOPE OF WORK**

- A. Section Includes:
  - 1. Rectangular and square ceiling diffusers.
  - 2. Louver face diffusers.
  - 3. Linear bar diffusers.
  - 4. Linear slot diffusers.
  - 5. Adjustable bar, registers and grilles
  - 6. Eggcrate Grille with Filter Frames

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
  - 1. Ceiling suspension assembly members.
  - 2. Method of attaching hangers to building structure.
  - 3. Size and location of initial access modules for acoustical tile.
  - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
  - 5. Duct access panels.
    - a. Source quality-control reports.

**PART 2 - PRODUCTS**

**2.1 CEILING DIFFUSERS**

- A. Rectangular and Square Ceiling Diffusers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      - i. Anemostat Products; a Mestek company.
      - ii. Krueger.
      - iii. METALAIRE, Inc.
      - iv. Nailor Industries Inc.

- v. Price Industries.
  - vi. Titus.
- 2. Devices shall be specifically designed for variable-air-volume flows.
- 3. Material: Aluminum.
- 4. Finish: White baked enamel, unless noted otherwise.
- 5. Face Size: See Plans.
- 6. Face Style: Three cone.
- 7. Mounting: Surface T-bar
- 8. Pattern: Fixed
- 9. Dampers: Radial opposed blade.

B. Louver Face Diffuser

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - i. Anemostat Products; a Mestek company.
    - ii. METALAIRE, Inc.
    - iii. Nailor Industries Inc.
    - iv. Price Industries.
    - v. Titus.
- 2. Devices shall be specifically designed for variable-air-volume flows.
- 3. Material: Aluminum.
- 4. Finish: Custom color selected by Architect.
- 5. Face Size: See Plans.
- 6. Mounting: Surface and T-bar.
- 7. Pattern: Four-way core style.
- 8. Dampers: Radial opposed blade.
- 9. Accessories:
  - a. Square to round neck adaptor.
  - b. Adjustable pattern vanes.
  - c. Throw reducing vanes.

## 2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Bar Diffuser

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - i. Anemostat Products; a Mestek company.
    - ii. Krueger.
    - iii. METALAIRE, Inc.
    - iv. Nailor Industries Inc.
    - v. Price Industries.
    - vi. Titus.
- 2. Devices shall be specifically designed for variable-air-volume flows.
- 3. Material: Aluminum.
- 4. Finish: White baked enamel, unless noted otherwise.
- 5. Wide Core Spacing Arrangement: 1/8-inch thick blades spaced 1/2 inch apart, zero 15-degree deflection.
- 6. Wide Core Spacing Arrangement: 3/16-inch thick blades spaced 1/2 inch apart, zero 15 or 30-degree deflection.
- 7. Narrow Core Spacing Arrangement: 1/8-inch thick blades spaced 1/4 inch apart, zero 15degree deflection.
- 8. One-Way Deflection Vanes: Extruded construction fixed louvers with removable core.
- 9. Frame: 1- inches wide.
- 10. Mounting: Concealed bracket.
- 11. Damper Type: Adjustable opposed-blade assembly.

B. Linear Slot Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - i. Anemostat Products; a Mestek company.
    - ii. Krueger.
    - iii. METALAIRE, Inc.
    - iv. Nailor Industries Inc.
    - v. Price Industries.
    - vi. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material - Shell: Aluminum, insulated.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish: White baked enamel, unless noted otherwise.
6. Number of Slots: as required or noted.
7. Length: See Plans.
8. Accessories: Plaster frame or T-bar slot.

## 2.3 REGISTERS AND GRILLES

### A. Adjustable Bar Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - i. Anemostat Products; a Mestek company.
    - ii. Krueger.
    - iii. METALAIRE, Inc.
    - iv. Nailor Industries Inc.
    - v. Price Industries.
    - vi. Titus.
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal spaced 3/4 inches apart.
5. Core Construction: Removable.
6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
7. Frame: 1 inch wide.
8. Mounting Frame: Filter
9. Mounting: Countersunk screw or Lay in.
10. Damper Type: Adjustable opposed blade.
11. Accessories:
  - a. Front-blade gang operator.

### B. Adjustable Bar Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - i. Anemostat Products; a Mestek company.
    - ii. Krueger.
    - iii. METALAIRE, Inc.
    - iv. Nailor Industries Inc.
    - v. Price Industries.
    - vi. Titus.
2. Material: Aluminum
3. Finish: White baked enamel, unless noted otherwise.
4. Face Blade Arrangement: Horizontal spaced 3/4 inches apart.
5. Core Construction: Integral
6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
7. Frame: 1 inch wide.
8. Mounting: Countersunk screw or Lay in.

C. Eggcrate Grille with Filter Frames:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - i. Anemostat Products
    - ii. Krueger
    - iii. METALAIRE, Inc.
    - iv. Nailor Industries Inc.
    - v. Price Industries
    - vi. Titus
2. Material: Aluminum Grid and border with filter frame
3. Finish: White baked enamel, unless noted otherwise. Finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes.
4. Mounting: Countersunk screw
5. Return grilles must provide a free area of at least 90%.
6. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch and shall have countersunk screw holes for a neat appearance.
7. Border width shall be 1¼ inches on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame.
8. Aluminum grid shall be ½ x ½ x ½ inch. Grille shall be provided with a filter frame for a standard 1-inch filter to fit the specified duct size.
9. The manufacturer shall provide published performance data for the grille.
10. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make  
  
final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

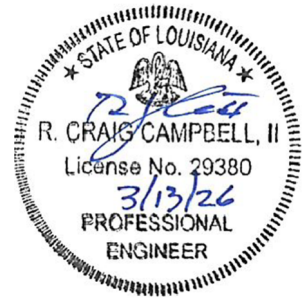
3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13







## SECTION 23 80 00

### AIR CONDITIONING, HEATING AND VENTILATING

#### 1.1 GENERAL

- A. The air conditioning system, in general, shall be for the entire building, providing cooling and dehumidification in summer and heating in winter. A constant amount of outside air shall be taken into the system and all air shall be filtered.

#### 1.2 HIGH EFFICIENCY CONDENSING UNIT- OUTDOOR SECTION

- A. Furnish and install high-efficiency, air-cooled top discharge condensing unit where shown and with capacities scheduled. UNIT SHALL BE COMPLETELY FACTORY ASSEMBLED, PRE-CHARGED AND TESTED, AND SHALL BE SUPPLIED FROM THE FACTORY WITH ALL FEATURES LISTED BELOW.
- B. Condenser coil shall be constructed of aluminum fins mechanically bonded to an aluminum coil and shall be protected with stamped louvered panels on outside of unit.
- C. Condenser fan shall be propeller type, direct driven. Motor shall have inherent protection and be of the permanently lubricated type, resiliently mounted. Fans shall be complete with safety guards.
- D. Compressor shall be a single speed serviceable hermetic or sealed hermetic design complete with crankcase heater and external spring isolators and compressors, and shall have a 5-year warranty. Unit shall be equipped with time delay to prevent compressor from starting within five minutes of "off" time.
- E. All controls shall be factory wired and shall consist of condenser fan overload devices, hard start kit (single phase only), internal pressure relief valve, filter dryers, pressure taps for refrigerant check, quick connect refrigerant couplings and liquid and suction line service valves. Unit shall also be furnished with outdoor expansion valve or metering valve and check valve, switch-over valve, time and temperature defrost control system, "thermister" outdoor temperature sensor and an evaporator defrost control kit to permit the cooling system to operate down to 30oF outdoor temperature.
- F. Casing shall be fully weatherproof for outdoor installation and shall be bonderized steel with baked enamel finish. Panels shall be removable to provide access for servicing. Unit shall be set in place on rubber mounting pads.
- G. Contractor shall advise the Electrical Contractor of the manufacturer's recommended fuse size if different from that specified on the Electrical Drawings. Mechanical Contractor shall pay any additional costs required to change fuse sizes.
- H. Units shall be Lennox or prior approved equivalent.

#### 1.3 HIGH EFFICIENCY AIR CONDITIONING UNIT- INDOOR SECTION

- A. Furnish and install vertical discharge/bottom return, or horizontal type (as indicated on plans) air conditioning unit of size, type and capacities as scheduled. Units shall be Lennox or prior approved equivalent.
- B. Units shall be complete with fan, multi-speed direct drive blower, motor, direct expansion cooling coil, low voltage control transformer, grease fittings, drain pan, etc. All units shall be factory insulated on the interior with not less than 3/4# density neoprene coated fiberglass cemented in place with waterproof adhesive.
- C. Each unit shall be mounted on a suitable base as indicated on plans or 18" (minimum) high painted angle iron base approved by the Engineer to allow for proper return air. Unit shall also be designed for continuous operation at the maximum rated static pressure. Fan capacities shall be rated with the fans in the units, and the horsepowers specified shall include all losses.
- D. Casings shall be suitable for operation at the pressures specified and constructed of bonderized steel.
- E. Cooling coils shall be of aluminum or copper and shall be tested at 400 psi air pressure. Cooling coil face velocity shall not exceed that guaranteed by manufacturer for no moisture carry-over.

- F. Electric strip heaters shall be as hereinafter specified and shall be mounted inside unit housing. Coordinate electric service to heaters and blower with Electrical Contractor. Heater and air unit shall be internally wired and fused to receive one electrical source of power.
- G. Filter shall be 1" thick, pleated, throw-way mounted in an accessible factory filter rack at unit.
- H. Contractor shall provide a new set of filters upon completion of project, to turn building over to Owner.
- I. If the manufacturer's equipment is not available internally wired to receive one source of power, necessary modifications to electric service shall be the responsibility of the equipment supplier. Any modifications required shall be submitted in writing ten (10) days prior to the bid date.

#### 1.4 ELECTRIC STRIP HEATERS

- A. Electric strip heaters shall consist of open coils made from Grade "A" resistant wire insulated by floating ceramic bushings and supported in an aluminum steel frame.
- B. All terminal studs, nuts and washers shall be stainless steel, insulated with phenolic terminal bushings. Terminals shall be machine crimped to coils and heater shall be tested at 2000 volts before shipment. All voltages and phases shall be as scheduled.
- C. Heater shall be provided with built-in contactors, with one terminal block furnished for each circuit and separate contactors for each stage of heating. Heaters with air units supplying 2000 CFM or less shall be internally wired with air unit to receive one electric source of power.
- D. An automatic reset thermal cut-off shall be provided to break the heater load directly on over-temperature. In addition, provide manual reset thermal cut-off to break the heater load manually.
- E. Control circuit transformer shall be built into heater terminal box and sized to carry full contactor holding coil load.
- F. Heaters shall be listed by UL and shall be as manufactured by Chromalox, Electric Heaters, Inc., Industrial Engineering and Equipment Co., or an approved equivalent.
- G. Heater shall be equipped with built-in pressure type air flow switch. Heater shall be mounted inside unit housing.
- H. Where indicated on drawings, heaters in ductwork shall be provided with duct flanges. Outside of heater shall be wrapped with 2.33" thick fiberglass ductwrap with aluminum foil vapor barrier.

#### 1.5 TESTING REFRIGERANT PIPING SYSTEMS

- A. Refrigerant lines shall be tested under 200 psi carbon dioxide pressure for 5 hours using soap suds at joints to test for leaks. Evacuate system and charge with refrigerant.

#### 1.6 LABELING A/C UNITS:

- A. All indoor and outdoor a/c units shall be labeled with permanent laminated plate riveted to unit. Units shall be labeled as indicated in schedules. Plate shall be black with white unit numbers. Height of unit number shall be minimum of one (1) inch. Label shall also indicate area serviced by unit as noted in schedules. Height of letters shall be minimum of one-half (½) inch. Submit sample to Engineer for approval.

#### 1.7 EMERGENCY DRAIN PAN (DX Equipment)

- A. All vertical split system air handling units shall be installed on 18"-24" high welded angle iron support in an emergency drain pan. Allow proper clearance for R.A. duct connection and removal of filters, etc.
- B. Drain pans shall be constructed of 20-gauge galvanized metal. Pan shall extend 4" beyond the edge of the unit. The sides of the pan shall be 4" high with drain connection located inside of the pan.
- C. Provide 3/4" Type "L" hard copper drain line with valve and pipe to floor drain in mechanical room.



1.8 VENTILATING SYSTEM

- A. This Contractor shall furnish and install all exhaust fans shown and scheduled on Plans. Fans shall be of the type indicated and shall be Cook, Greenheck, Acme, PennBarry, Broan, Twin City, ILG/American coolair, or approved equivalent.
- B. Ceiling mounted fans shall be complete with white ceiling mounted grille. Grille shall be removable to provide service access to fan, motor, etc.

END OF SECTION 23 80 00



**SECTION 23 80 25**  
**DECENTRALIZED HVAC EQUIPMENT**



**PART 1 – GENERAL**

**1.1 SYSTEM DESCRIPTION**

- A. The variable capacity, heat pump heat recovery air conditioning system shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system.
- B. The R2-Series system shall consist of a PURY outdoor unit, BC (Branch Circuit) Controller, multiple indoor units, and M-NET DDC (Direct Digital Controls). Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. To ensure owner comfort, each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.
- C. The split system (DOAS) shall consist of one VRF (Variable Refrigerant Flow) outside unit connected to one ducted indoor unit. The DOAS shall be provided with the capability to reheat air using recovered energy from the primary cooling coil or provide a primary cooling coil only. The DOAS shall be of a split system type.

**1.2 QUALITY ASSURANCE**

- A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
- B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
- C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.
- E. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

**1.3 DELIVERY, STORAGE AND HANDLING**

- A. Unit shall be stored and handled according to the manufacturer's recommendation.

**1.4 CONTROLS**

- A. The control system shall consist of a low voltage communication network of unitary built-in controllers with on-board communications and a web-based operator interface. A web controller with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
- B. System controls and control components shall be installed in accordance with the manufacturer's written installation instructions.
- C. Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
- D. System shall provide direct and reverse-acting on and off algorithms based on an input condition or group conditions to cycle a binary output or multiple binary outputs.
- E. Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.

1)

- F. System shall be capable of email generation for remote alarm annunciation.
- G. Control system start-up shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in Mitsubishi Electric controls system configuration and operation. The representative shall provide proof of certification for Mitsubishi Electric Controls Applications Training indicating successful completion of no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals. This service shall be equipment and system count dependent and shall be a minimum of one (1) eight (8) hour period to be completed during normal working hours.

## 1.5 WARRANTY

- A. The CITY MULTI units shall be covered by the manufacturer's limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.
- B. If the systems are:
  - 1. designed by a certified CITY MULTI Diamond Designer using Diamond System Builder,
  - 2. installed by a contractor that has successfully completed the Mitsubishi Electric three day service course, AND
  - 3. verified with required materials submitted to and approved by the Mitsubishi Electric Service Department, which include:
    - a. As built Diamond System Builder file,
    - b. A one (1) hour Maintenance Tool record with system information, in Ordinary Control Mode (not initial),
    - c. Outdoor and Indoor unit dip switch settings
    - d. Outdoor unit(s) function settings,
- C. then the units shall be covered by an extended manufacturer's limited warranty for a period of ten (10) years to the original owner from date of installation.
- D. In addition, the compressor shall have a manufacturer's limited warranty for a period of ten (10) years to the original owner from date of installation.
- E. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.
- F. This warranty shall not include labor.
- G. Manufacturer shall have a minimum of thirty-three (33) years of HVAC experience in the U.S. market.
- H. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.
- I. The CITY MULTI VRF system shall be installed by a contractor with extensive CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

## PART 2 – PRODUCTS

### 2.1 R2-SERIES OUTDOOR UNIT

- A. General: The R2-Series PURY outdoor unit shall be used specifically with CITY MULTI VRF components. The PURY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
  - 1. The model nomenclature and unit requirements are shown below. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If

an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.

<b>Outdoor Unit Model Nomenclature</b>		
<b>208/230 Volt</b>		<b>Twinning Kit</b>
<b>Model Number</b>	<b>Units</b>	
PURY-P72TKMU	(1) PURY-P72TKMU	None
PURY-P96TKMU	(1) PURY-P96TKMU	None
PURY-P120TKMU	(1) PURY-P120TKMU	None
PURY-P144TKMU	(1) PURY-P144TKMU	None
PURY-P168TSKMU	PURY-P96TKMU (1) PURY-P72TKMU	CMY-R100CBK2
PURY-P192TSKMU	(2) PURY-P96TKMU	CMY-R100CBK2
PURY-P216TSKMU	PURY-P96TKMU (1) PURY-P120TKMU	CMY-R100XLCBK
PURY-P240TSKMU	(2) PURY-P120TKMU	CMY-R100XLCBK
PURY-P264TSKMU	PURY-P120TKMU (1) PURY-P144TKMU	CMY-R100XLCBK
PURY-P288TSKMU	(2) PURY-P144TKMU	CMY-R100XLCBK

2. Outdoor unit shall have a sound rating no higher than 60 dB(A) individually or 64 dB(A) twinned. Units shall have a sound rating no higher than 50 dB(A) individually or 53 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
3. Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated in accordance with the installation manual.
4. There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.
5. Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.
6. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
7. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
8. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 1804-2625 feet. The greatest length is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.
9. The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperatures or cooling mode down to 23°F ambient temperatures, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.

10. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
  11. The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
  12. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend “no or reduced heating” periods shall not be allowed.
- B. Unit Cabinet:
1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished. Units cabinets shall be able to withstand 960 hours per ASTM B117 criteria for seacoast protected models (–BS models)
- C. Fan:
1. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
  2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
  3. All fan motors shall be mounted for quiet operation.
  4. All fans shall be provided with a raised guard to prevent contact with moving parts.
  5. The outdoor unit shall have vertical discharge airflow.
- D. Refrigerant
1. R410A refrigerant shall be required for PURY-P-Y-A outdoor unit systems.
  2. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
- E. Coil:
1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
  2. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
  3. The coil shall be protected with an integral metal guard.
  4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
  5. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.
- F. Compressor:
1. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
  2. A crankcase heater(s) shall be factory mounted on the compressor(s).
  3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19%-5% of rated capacity, depending upon unit size.
  4. The compressor will be equipped with an internal thermal overload.
  5. The compressor shall be mounted to avoid the transmission of vibration.
  6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
- G. Controls:
1. The outdoor unit shall have the capability of up to 8 levels of demand control for each refrigerant system
- H. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.
2. The outdoor unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz), 207-253V (230V/60Hz).
3. The outdoor unit shall be controlled by integral microprocessors.
4. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

## 2.2 BRANCH CIRCUIT (BC) CONTROLLERS FOR R2-SERIES SYSTEMS

- A. The BC (Branch Circuit) Controllers shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling risk bubbles in liquid supplied to LEV and are not allowed.
- B. The BC (Branch Circuit) Controllers shall be specifically used with R410A R2-Series systems. These units shall be equipped with a circuit board that interfaces to the M-NET controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity. The BC Controller shall be suitable for use in plenums in accordance with UL1995 ed 4.
- C. BC Unit Cabinet:
  1. The casing shall be fabricated of galvanized steel.
  2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
  3. The unit shall house two tube-in-tube heat exchangers.
- D. Refrigerant
  1. R410A refrigerant shall be required.
- E. Refrigerant Branches
  1. All BC Controller refrigerant pipe connections shall be brazed or flared.
- F. Refrigerant valves:
  1. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
  2. All branches shall have
  3. Each branch shall have multiple two-position valves to control refrigerant flow.
  4. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
  5. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
  6. Future Use
  7. Each VRF system shall include at least one (1) unused branches or branch devices for future use. Branches shall be fully installed & wired in central location with capped service shutoff valve & service port.
- G. Integral Drain Pan:
  1. An Integral resin drain pan and drain shall be provided
- H. Electrical:
  1. The unit electrical power shall be 208/230 volts, 1 phase, 60 Hertz.
  2. The unit shall be capable of satisfactory operation within voltage limits of 187-228 (208V/60Hz) or 207-253 (230/60Hz).
  3. The BC Controller shall be controlled by integral microprocessors

4. The control circuit between the indoor units and outdoor units shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

### 2.3 Y-SERIES HIGH EFFICIENCY (HEAT PUMP), AIR-COOLED OUTDOOR UNITS

#### A. General:

1. The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section and Part 5 (Controls). The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards—all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
2. Outdoor unit systems may be comprised of multiple modules with differing capacity if a brand other than basis of design is proposed. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.
3. Outdoor unit shall have a sound rating no higher than 68 dB(A) individually or 69.5 dB(A) twinned. Units shall have a sound rating no higher than 55 dB(A) individually or 55.5 dB(A) twinned while in night mode operation. Units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
4. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
5. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.
6. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.
7. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
8. VRF system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
9. The outdoor unit shall be capable of guaranteed operation in heating mode down to -25F ambient temperatures and cooling mode up to 126°F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as "for reference only" are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and labor to meet ambient operating range and performance shall be incurred by the contractor.
10. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.
11. Unit must defrost all circuits simultaneously in order to resume full heating more quickly during extreme low ambient temperatures (below 23F). Partial defrost, also known as hot gas defrost which allows reduced heating output during defrost, is permissible only when ambient temperature is above 23F.
12. While in hot gas defrost the system shall slow the indoor unit fan speed down to maintain a high discharge air temperature, systems that keep fan running in same state shall not be allowed as they provide an uncomfortable draft to the indoor zone due to lower discharge air temperatures.

#### B. Unit Cabinet:

1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
2. The outdoor unit shall be tested in compliance with ISO9277 such that no unusual rust shall develop after 960 hours of salt spray testing.



3. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised and the panel should be replaced immediately.

C. Fan:

1. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG external static pressure, but capable of normal operation with a maximum of 0.32 in. WG external static pressure via dipswitch.
2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. All fans shall be provided with a raised guard to prevent contact with moving parts.
4. Refrigerant and Refrigerant Piping
5. R410A refrigerant shall be required for systems.
6. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
7. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.
8. All refrigerant piping must be insulated with ½" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
9. Refrigerant line sizing shall be in accordance with manufacturer specifications.

D. Coil:

1. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.
2. Outdoor Coil shall be elevated at least 12" from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturer's in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12" of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.
3. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction. The coil fins shall have a factory applied corrosion resistant finish. Uncoated aluminum coils/fins are not allowed.
4. The coil shall be protected with an integral metal guard.
5. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
6. Unit shall have prewired plugs for optional panel heaters in order to prevent any residual ice buildup from defrost. Panel heaters are recommended for operating environments where the ambient temperature is expected to stay below -1F for 72 hours.
7. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.

E. Compressor:

1. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.
2. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.
3. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed. Manufacturers that utilize belly-band crankcase heaters will be considered as alternate only.

4. Compressor shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.
5. The compressor shall be equipped with an internal thermal overload.
6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
7. Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.

F. Controls:

1. The unit shall be an integral part of the system & control network described in Part 5 (Controls) and react to heating/cooling demand as communicated from connected indoor e control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.
2. The outdoor unit shall have the capability of 4 levels of demand control for each refrigerant system based on external input.

G. Electrical:

1. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz or 460 volts, 3-phase, 60 hertz per equipment schedule.
2. The outdoor unit shall be controlled by integral microprocessors.
3. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

## 2.4 PKFY (Wall Mounted) INDOOR UNIT

A. The PKFY shall be a wall-mounted indoor unit section and shall have a modulating linear expansion device and a flat front. The PKFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PKFY shall support individual control using M-NET DDC controllers.

B. Indoor Unit

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:

1. All casings, regardless of model size, shall have the same white finish
2. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
3. There shall be a separate back plate which secures the unit firmly to the wall.

D. Fan:

1. The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
4. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

E. Filter:

1. Return air shall be filtered by means of an easily removable, washable filter.

F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. Both refrigerant lines to the PKFY indoor units shall be insulated in accordance with the installation manual.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)

H. Controls:

1. This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 4 of this guide specification for details on controllers and other control options.
2. The unit shall be able to control external backup heat.
3. The unit shall have a factory built in receiver for wireless remote control
4. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
5. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
6. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
7. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.5 PLFY-P\*\*NEMU-E\* (4-WAY CEILING-RECESSED CASSETTE WITH GRILLE) INDOOR UNIT

A. General

1. The PLFY-P\*\*NEMU-E\* shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:

1. The cabinet shall be space-saving ceiling-recessed cassette.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
3. Branch ducting shall be allowed from cabinet.
4. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
5. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space

C. Fan:

1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto.
4. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.

5. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
6. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
7. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
8. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space. Filter:
9. Return air shall be filtered by means of a long-life washable filter

D. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.
7. Both refrigerant lines to the PLFY indoor units shall be insulated in accordance with the installation manual.

E. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

F. Controls:

1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

## 2.6 PLFY-P\*\*NFMU-ER4 (4-WAY CEILING-RECESSED CASSETTE WITH GRILLE) INDOOR UNIT

A. General:

1. The PLFY-P\*\*NFMU-ER4 shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:

1. The cabinet shall be a compact 22-7/16" wide x 22-7/16" deep so it will fit within a standard 24" square suspended ceiling grid.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
3. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.

C. Fan:

1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of three (3) speeds, Low, Mid, and High.
4. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
5. The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution.

D. Filter:

1. Return air shall be filtered by means of a long-life washable filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan.
7. Both refrigerant lines to the PLFY indoor units shall be insulated in accordance with the installation manual.
8. Electrical:
9. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
10. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

F. Controls:

1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

## 2.7 PMFY (1-WAY CEILING-RECESSED CASSETTE WITH GRILLE) INDOOR UNIT

A. General:

1. The PMFY shall be a one-way cassette indoor unit that recesses into the ceiling with a ceiling grille and shall have a modulating linear expansion device. The PMFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PMFY shall support individual control using M-NET DDC controllers.

B. Indoor Unit.

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:

1. The cabinet shall be space-saving ceiling recessed.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
3. Branch ducting shall be allowed from cabinet.
4. The one-way grille shall be fixed to bottom of cabinet allowing for one-way airflow.

D. Fan:

1. The indoor fan shall be an assembly with one line-flow fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High.

E. Filter:

1. Return air shall be filtered by means of a long-life washable permanent filter.

F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 23 inches above the condensate pan.
7. Both refrigerant lines to the PMFY indoor units shall be insulated in accordance with the installation manual.
8. Electrical:
9. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
10. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

G. Controls:

1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

## 2.8 PEFY-NMAU (CEILING-CONCEALED DUCTED) INDOOR UNIT

A. General:

1. The PEFY shall be a ceiling-concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The PEFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY shall support individual control using M-NET DDC controllers. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Indoor Unit.

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
- C. Unit Cabinet:
1. The unit shall be, ceiling-concealed, ducted.
  2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
- D. Fan:
1. PEFY-NMAU models shall feature external static pressure settings from 0.14 to 0.60 in. WG.
  2. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
  3. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
  4. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function
  5. The indoor unit shall have a ducted air outlet system and ducted return air system.
- E. Filter:
1. Return air shall be filtered by means of a standard factory installed return air filter.
  2. Optional return filter box (rear or bottom placement) with high-efficiency filter shall be available for all PEFY indoor units.
- F. Coil:
1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
  2. The tubing shall have inner grooves for high efficiency heat exchange.
  3. All tube joints shall be brazed with phos-copper or silver alloy.
  4. The coils shall be pressure tested at the factory.
  5. A condensate pan and drain shall be provided under the coil.
  6. The condensate shall be gravity drained from the fan coil.
  7. Both refrigerant lines to the PEFY indoor units shall be insulated in accordance with the installation manual.
- G. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
  2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
- H. Controls:
1. This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
  2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
  3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
  4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
  5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.9 PEFY-NMH(S)U (ALTERNATE HIGH STATIC OPTION), CEILING-CONCEALED DUCTED INDOOR UNIT

A. General:

1. The PEFY-NMH(S)U (Alternate High Static Option) unit shall be a ceiling concealed ducted indoor fan coil that mounts above the ceiling with a fixed rear return and a horizontal discharge supply, and shall have a modulating linear expansion device. The PEFY-NMH(S)U shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY-NMH(S)U shall support individual control using M-NET DDC controllers. PEFY-NMH(S)U models shall feature external static pressure settings up to 1.00 in. WG. Units shall have the ability to control supplemental heat via connector CN24 or CN4F and a 12 VDC output. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Indoor Unit.

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

C. Unit Cabinet:

1. The cabinet shall be ceiling-concealed, ducted.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

D. Fan:

1. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor unit shall have a ducted air outlet system and ducted return air system.

E. Filter:

1. Return air shall be filtered by a field-supplied filter.
2. Optional rear return filter box with long-life filter shall be available for all PEFY-NMH(S)U-E indoor units.

F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phosphor-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The condensate shall be gravity drained from the fan coil.
7. Both refrigerant lines to the PEFY indoor units shall be insulated in accordance with the installation manual.

G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

H. Controls:

1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.



2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

## 2.10 PCFY (CEILING-SUSPENDED) INDOOR UNIT

### A. General:

1. The PCFY shall be ceiling-suspended indoor unit section and have a modulating linear expansion device. The PCFY shall be used with the R2-Series outdoor unit and BC Controller(s), Y-Series outdoor unit, or S-Series outdoor unit. The PCFY shall support individual control using M-NET DDC controllers.

### B. Indoor Unit

1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. The unit shall have an auto-swing function for the horizontal vane. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

### C. Unit Cabinet:

1. The casing shall have a white finish.

### D. Fan:

1. The indoor unit fan shall be an assembly with two, three, or four Sirocco fan(s) direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High, and Auto fan function.

### E. Filter:

1. Return air shall be filtered by means of an easily removable, washable filter.

### F. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. Both refrigerant lines to the PCFY indoor units shall be insulated in accordance with the installation manual.

### G. Electrical:

1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)

### H. Controls:

1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
2. Units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
6. Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.
7. The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts

### PART 3 CONTROLS

#### 3.1 OVERVIEW

##### A. General:

1. The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.

#### 3.2 ELECTRICAL CHARACTERISTICS

##### A. General:

1. The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

##### B. Wiring:

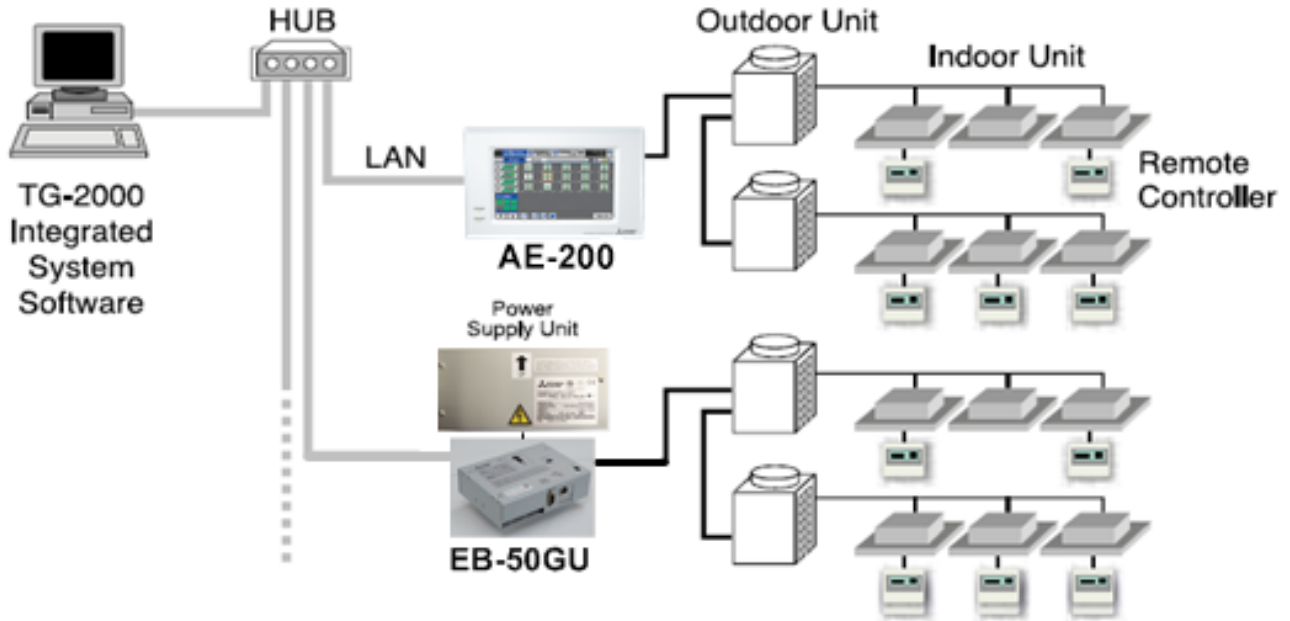
1. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
2. Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.
3. Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.
4. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
5. The AE-200, AE-50, and EB-50GU centralized controller shall be capable of being networked with other AE-200, AE-50, and EB-50GU centralized controllers for centralized control.

##### C. Wiring type:

1. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
2. Network wiring shall be CAT-5 with RJ-45 connection.

##### D. CITY MULTI Controls Network:

1. The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.



**CMCN System Configuration**

**E. CMCN: Remote Controllers Backlit Simple MA Remote Controller (PAC-YT53CRAU)**

1. The Backlit Simple MA Remote Controller (PAC-YT53CRAU) shall be capable of controlling up to 16 indoor units (defined as 1 group). The Backlit Simple MA Remote Controller shall be compact in size, approximately 3" x 5" and have limited user functionality. The Backlit Simple MA supports temperature display selection of Fahrenheit or Celsius. The Backlit Simple MA Remote Controller shall allow the user to change on/off, mode (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, and fan speed setting and airflow direction. The Backlit Simple MA Remote Controller shall be able to limit the set temperature range from the Backlit Simple MA. The Backlit Simple MA Remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Backlit Simple MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Backlit Simple MA Remote Controller shall display a four-digit error code in the event of system abnormality/error.
2. The Backlit Simple MA Remote Controller shall only be used in same group with Wireless MA Remote Controllers (PAR-FL32MA-E / PAR-FA32MA-E) or with other Backlit Simple MA Remote Controllers (PAC-YT53CRAU), with up to two remote controllers per group.
3. The Backlit Simple MA Remote Controller shall require no addressing. The Backlit Simple MA Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB15 connection terminal on the indoor unit. The Simple MA Remote Controller shall require cross-over wiring for grouping across indoor units.

<b>PAC-YT53CRAU (Backlit Simple MA Remote Controller)</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group

<b>PAC-YT53CRAU (Backlit Simple MA Remote Controller)</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit.  Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Group *1
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display “test run”).	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temperature Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group

### 3.3 CENTRALIZED CONTROLLER (WEB-ENABLED)

#### A. AE-200 Centralized Controller

- The AE-200A Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three (3) AE-50A expansion controllers. The AE-200A Centralized Controller shall be approximately 11-5/32” x 7-55/64” x 2-17/32” in size and shall be powered with an integrated 100-240 VAC power supply. The AE-200A Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the AE-200A Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the AE-200 Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the AE-200A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the AE-200A Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

<b>AE-200 (Centralized Controller)</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit.	Each Block, Group or Collective	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can be scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Setback Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Room Temp	Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Outdoor Unit Status	Compressor capacity percentage and system pressure (high and low) pressure (excludes S-Series)	Each ODU	Each ODU
Connected Unit Information	MNET addresses of all connected systems	Each IDU, ODU and BC	Each IDU, ODU and BC
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.	Each Group	Each Group
Multiple Language	Other than English, the following language can be chosen. Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese are available.	N/A	Collective

<b>AE-200 (Centralized Controller)</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
External Input / Output	By using accessory cables you can set and monitor the following. Input By level: "Batch start/stop", "Batch emergency stop" By pulse: "batch start/stop", "Enable/disable remote controller" Output: "start/stop", "error/Normal" Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective

2. All AE-200A Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three AE-50A expansion controllers for display of up to two hundred (200) indoor units on the main AE-200A interface.
3. The AE-200A Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.

- B. Standard software functions shall be available so that the building manager can securely log into each AE-200A via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Tenant Billing shall be available but are not included. The Tenant Billing function shall require TG-2000 Integrated System software in conjunction with the Centralized Controllers.

### 3.4 AE-50A EXPANSION CONTROLLER

- A. The AE-50A Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the AE-200A Centralized Controller for the purpose of adding up to 50 indoor units to either the main touch screen interface of the AE-200A. Up to three (3) AE-50A expansion controllers can be connected to the AE-200A via a local IP network (and their IP addresses assigned on the AE-200A) to the AE-200A to allow for up to two hundred (200) indoor units to be monitored and controlled from the AE-200A interface.
- B. The AE-50A expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the AE-200A and configured to display their units on the main controller, the individual indoor units connected to the AE-50A can still be monitored and controlled from the interface of the AE-50. The last command entered will take precedence, whether at the wall controller, the AE-50A or the AE-200A Centralized Controller.

### 3.5 Non Touch Screen, Networked Centralized Controller:

- A. The Non Touch Screen, Networked Centralized Controller shall be capable of controlling a maximum of 50 indoor units across multiple CITY MULTI outdoor units. The controller shall be approximately 8-1/2"x10" in size and shall be powered by its internal power supply. The controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, free contact interlock configuration and malfunction monitoring. The controller shall have five basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, temperature setting, fan speed setting, and airflow direction setting. Since the controller provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

<b>Non Touch Screen, Networked Centralized Controller</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Indoor unit modes: COOL/DRY/FAN/AUTO/HEAT. Lossnay unit modes: HEAT RECOVERY/BYPASS/AUTO Air to water (PWFY) modes: HEATING/HEATING ECO/HOT WATER/ANTI-FREEZE/COOLING	Each Block, Group or Collective	Each Group

<b>Non Touch Screen, Networked Centralized Controller</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
	*Operation modes vary depending on the unit model connected. ** Auto mode is available for the R2/WR2-Series only.		
Temperature Setting	Sets the temperature from 40°F – 95°F depending on operation mode and indoor unit model.  Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.	Each Block, Group or Collective	Each Group
Set Temperature Range Limit	The range of room temperature setting can be limited by the initial setting depending on the indoor unit connected.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depend on indoor unit model.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	*Air flow direction settings vary depending on the indoor unit model. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. *2. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can be scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group
Hold	Disables scheduled functions for indoor unit groups and their associated remote controller timers. *not available for general equipment	Each Block, Group or Collective	Each Group
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Fan Speed, Air Direction and Reset filter). Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Room Temp	Displays the room temperature of the group.	N/A	Each Group
Room Humidity	Displays the percent relative humidity in the space as sensed by the Smart ME Remote Controller	N/A	Each Group
Occupancy Sensor	Displays the occupancy icon on the group icon in the condition list page when the room is occupied (blue) or vacant (gray). *The Smart ME Remote Controller Occupancy sensor is required.	N/A	Each Group
Brightness Sensor	Displays the brightness icon on the group icon in the condition list when the space is determined to be bright (yellow) or dark (gray). *The Smart ME Remote Controller Brightness sensor is required.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”.	Each Group	Each Group

<b>Non Touch Screen, Networked Centralized Controller</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
	When setting a group of only free plan LOSSNAY units, you can switch between "Normal ventilation", "Interchange ventilation" and "Automatic ventilation".		
Multiple Language	Other than English, the following languages can be selected: Spanish, French, Japanese, German, Italian, Russian, Chinese, and Portuguese.	N/A	N/A
External Input / Output	By using accessory cables you can set and monitor the following. Input: By level: "Batch start/stop", "Batch emergency stop"; By pulse: "batch start/stop", "Enable/disable remote controller" Output: "start/stop", "error/Normal" Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective
M-Net	The "M-NET" LED lights, when AC power supply is turned ON. The LED blinks while M-NET is communicating.	N/A	Each Group (LED)
Collective ON/OFF	All the units can be operated / stopped with a DIP switch.	Collective	N/A
Measurement	Displays the Temperature and Humidity inputs of the AI Board. Supports graph display and data export.	N/A	Each Unit
AHC Status	Displays the status of the of the inputs and outputs of each Advanced HVAC Controller (DC-A2IO)	N/A	Each Unit
Free Contact Status	Displays the input/output status of the Free Contacts on the indoor units	N/A	Each Unit
Free Contact Interlock Control	Operation of indoor groups, general equipment or free contact outputs based on group(s) conditions or free contact(s) input states.	Each Group, Output or Collective	N/A
Data Back-up (PC)	Initial setting data can be exported to a PC.	Collective	N/A

- B. All Non Touch Screen, Networked Centralized Controller shall be equipped with two RJ-45 Ethernet port to support interconnection with a network PC and BACnet/IP communication via a closed/direct Local Area Network (LAN). The controller shall be capable of performing initial settings online via a PC using the controller's initial setting browser or online/offline with the Initial Setting Tool.
- C. Standard software functions shall be available so that the building manager can securely log into each controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Standard software functions shall not expire. Additional optional software functions of personal browser for PCs and MACs and Energy Allocation shall be available. The Energy Allocation function shall require Master Centralized Controller Energy Allocation Integrated System in conjunction with Non Touch Screen, Networked Centralized Controller.

### 3.6 CMCN: SYSTEM INTEGRATION

- A. The CMCN shall be capable of supporting integration with Building Management Systems (BMS).

### 3.7 BAC-HD150: BACNET® INTERFACE

- A. The Mitsubishi Electric Cooling & Heating BACnet® interface, BAC-HD150, shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2004) and be Certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support BACnet Broadcast Management (BBMD). The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.

### 3.8 CENTRAL CONTROLLER (NON-WEB)

- A. Non-Networked Touch Controller:

1. The Non-Networked Touch Controller features a 5 inch wide color LCD touch panel. The settings for air conditioning units can be changed by touching the corresponding icons on the display. There are 3 buttons on the panel of the controller; ON/OFF, SET BACK and HOLD enabling simple and quick batch operation. One controller can control up to 24 groups/units of air conditioners. Operation status is displayed on easy-to-read LCD. The group currently operating can be seen at a glance with the operation status display. The controller can perform functions such as ON/OFF, Operation mode



changeover, temperature setting and prohibit operation by local remote controller. Up to 12 patterns of weekly schedule can be set. "ON/OFF", "Operation mode", "Set Temperature", "Fan speed", "Air flow direction" and "Permit / Prohibit local operation" can be scheduled with up to 16 settings in one pattern. Up to 5 patterns of today's schedule can be set. Independent LOSSNAY operation is possible. Automatic ventilation, Normal ventilation and Ventilation with heat exchanger can be switched from the system controller. The controller is equipped with a system changeover function which an operation mode can be switched to an optimal mode depending on indoor temperature setting and target temperature of each group or a representative indoor unit.

<b>Non-Networked Touch Controller:</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
ON/OFF	ON and OFF operation for the air conditioner units. Even when only a single indoor unit connected to the group remote controller will operate and collective ON/OFF lamp will light up.	Group or Collective	Group or Collective
Operation Mode Switching	Switches between Cool / Dry / Auto / Fan / Heat / Setback. Operation modes vary depending on the air conditioner unit. Auto mode is for CITY MULTI R2 and WR2 series only.	Group or Collective	Group or Collective
Temperature Setting	Set temperature from 57° F - 87° F depending on operation mode and indoor unit.  Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.	Group or Collective	Group or Collective
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Group or Collective	Group or Collective
Air Flow Direction Setting	Air flow direction angles 4-angle or 5-angle, Swing, Auto Louver ON/OFF * Air flow direction settings vary depending on the indoor unit model.	Group or Collective	Group or Collective
old	Hold Prohibits the scheduled operation from being executed. ON/OFF timer Auto-OFF timer Weekly timer Automatic return to the preset temperature * While an operation is prohibited by Hold function, the operation icon lights up.	Group or Collective	Group or Collective
Permit / Prohibit	When set as the master, the ON/OFF, operation mode, setting temperature and filter sign reset operations using the local remote controllers can be prohibited. Only ON/OFF and filter reset can be prohibited for the LOSSNAY group.	Group or Collective	Group or Collective
Operation Lock	(ON/OFF, operation mode, setting temperature, fan speed, Air flow direction)	Group or Collective	Group or Collective
Room Temp Display	The room temperature can be displayed.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed. * When an error occurs, the "ON/OFF" LED flashes. The operation monitor screen show abnormal icon over the unit. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection.	N/A	Each Unit, Group, or Collective
Schedule Operation	Weekly schedule setting up to 12 patterns is available. In one pattern, up to 16 setting of "ON/OFF", "Operation mode", "Set Temperature", "Fan speed", "Air flow direction" and "Permit / Prohibit local operation" can be scheduled. Today's schedule setting up to 5 pattern in available. *Time setting unit: 5 minute /unit	Each Group	Each Group
Ventilation Operation (Independent)	Group operation of only the free plan LOSSNAY is possible. The operation mode of these groups is automatic ventilation, ventilation with heat exchanger and normal ventilation.	Group or Collective	Group or Collective
Ventilation Operation (Interlocked)	The LOSSNAY will run in interlock with the operation of indoor unit. The mode cannot be changed. The LED will turn ON during operation after interlocking.	Group or Collective	Group or Collective
Set Temperature Range Limit	The range of room temperature setting can be limited by the initial setting. The lowest limit temperature can be made higher than the usual (67°F) in cool/dry mode, while the upper limit temperature lower than the usual (83°F) in heat mode.	Group or Collective	Group or Collective
External Input / Output	By using accessory cables you can set and monitor the following. Input	*5 Collective	*5 Collective

<b>Non-Networked Touch Controller:</b>			
<b>Item</b>	<b>Description</b>	<b>Operation</b>	<b>Display</b>
	By level: "Batch start/stop", "Batch emergency stop" By pulse: "batch start/stop", "Enable/disable remote controller" Output: "start/stop", "error/Normal" *5: Requires the external I/O cables (PAC-YG10HA-E) sold separately.		

END OF SECTION 23 80 25