



MHA-PALMS AT UNIVERSITY APARTMENTS

COMMISSION #: 15083.00

PROJECT MANUAL

VOLUME II

OCTOBER 12, 2017

DIVISION 15 – MECHANICAL

15010 - 13	General Mechanical Provisions	10/12/2017
15015 - 2	Sleeves	10/12/2017
15020 - 6	Hangers and Supports	10/12/2017
15025 - 3	Installation of Piping	10/12/2017
15040 - 3	Service Identification	10/12/2017
15060 - 8	Pipe, Tube and Fittings	10/12/2017
15065 - 2	Electrical Coordination	10/12/2017
15066 - 2	Piping Condensate Drain	10/12/2017
15080 - 5	Piping Specialties	10/12/2017
15100 - 9	Valves	10/12/2017
15160 - 2	Expansion Compensation	10/12/2017
15180 - 5	Insulation	10/12/2017
15210 - 4	Vibration Isolation	10/12/2017
15400 - 6	Plumbing	10/12/2017
15401 - 5	Sanitary Sewer and Sanitary Vent Piping	10/12/2017
15402 - 4	Dom. Cold & HW Supply Piping & HW Circulating Pumps	10/12/2017
15410 - 12	Plumbing Fixtures	10/12/2017
15421 - 2	Floor Drains and Shower Drains	10/12/2017
15423 - 1	Cleanouts and Cleanout Access Covers	10/12/2017
15425 - 2	Domestic Water Heaters – Electric	10/12/2017
15450 - 2	Plumbing Fixtures and Trim	10/12/2017
15465 - 4	Insulation for Plumbing Systems	10/12/2017
15499 - 2	Equipment Furnished Under Other Divisions	10/12/2017
15651 - 5	Refrigeration Piping Systems	10/12/2017
15673 - 3	Air-Cooled Condensing Units	10/12/2017
15715 - 5	Split System Air Conditioner	10/12/2017
15751 - 4	100% Outside Air Make-up Units	10/12/2017
15755 - 5	Air Handling Units	10/12/2017
15757 - 5	Ductless Mini-Split System	10/12/2017
15800 - 4	Air Distribution Devices	10/12/2017
15829 - 2	In-Line Fans	10/12/2017
15838 - 8	Power Ventilators	10/12/2017
15841 - 11	Low Pressure Ductwork	10/12/2017
15860 - 5	Duct Accessories	10/12/2017
15864 - 2	Smoke and Fire Dampers	10/12/2017
15872 - 2	Louvers	10/12/2017
15915 - 3	Programmable Thermostat	10/12/2017
15990 - 3	Test and Balance	10/12/2017
15992 - 6	Start Up	10/12/2017
15995 - 6	Fire Protection	10/12/2017

DIVISION 16 – ELECTRICAL

16010 - 10	Supplementary General Conditions	10/12/2017
16110 - 5	Raceways	10/12/2017
16120 - 5	Conductors and Cables	10/12/2017
16131 - 1	Junction and Pull Boxes	10/12/2017
16133 - 1	Cabinets	10/12/2017
16134 - 5	Outlet Boxes	10/12/2017
16140 - 4	Wiring Devices	10/12/2017
16142 - 3	Electrical Connections for Equipment	10/12/2017
16145 - 7	Occupancy Sensor Lighting Controls	10/12/2017
16155 - 1	Motor Starters	10/12/2017
16170 - 2	Motor and Circuit Disconnects	10/12/2017
16182 - 2	Circuit Breaker - New Construction	10/12/2017
16190 - 4	Supporting Devices	10/12/2017
16210 - 2	Metering Centers – Three Phase	10/12/2017
16289 - 4	Surge Protection Device (SPD) Systems	10/12/2017
16420 - 3	Service Entrance	10/12/2017
16440 - 7	Distribution Panelboards	10/12/2017
16441 - 3	Load Centers	10/12/2017
16442 - 4	Switchboards	10/12/2017
16443 - 9	Panelboards	10/12/2017
16450 - 4	Grounding	10/12/2017
16501 - 6	Lamps and Ballasts	10/12/2017
16510 - 8	Interior Lighting	10/12/2017
16720 - 11	Fire Alarm System	10/12/2017
16740 - 1	Telephone Systems	10/12/2017
16742 - 6	Voice/Data Network System	10/12/2017
16781 - 2	Cable Television System	10/12/2017
16865 - 3	Electric Duct Heater	10/12/2017

**SECTION 15010
GENERAL MECHANICAL PROVISIONS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 SCOPE OF DIVISION

- A. Work shall include all materials, equipment and labor necessary for a complete and properly functioning mechanical installation in accordance with local and state codes and contract drawings and specifications. Work shall be understood to include all work specified in Division 15000, Mechanical Section numbers 15000 through 15999, inclusive of the specifications.
- B. Refer to other divisions of these specifications for any work to be performed under alternate bid proposals.
- C. Pay for all required licenses, fees, inspections, permits and include in bid proposal.

1.03 CODES

- A. Where a conflict in code requirements occurs, the more stringent requirement shall govern.

1.04 STANDARDS

- A. All equipment and devices shall bear UL label, the label of an industry recognized approved testing agency or A.G.A. certification for said item of equipment or device.
- B. All electrical equipment and devices shall be UL approved (no exceptions).

1.05 DRAWINGS

- A. Architectural and structural drawings take precedence over mechanical drawings with reference to the building construction. Mechanical drawings are diagrammatic and indicate the general arrangement and extent of work. Architectural drawings indicate more exactly the desired relationship between diffusers, registers, lighting fixtures, equipment, electric panels and devices, plumbing fixtures and other items which remain exposed in the completed building. Exact locations and arrangement of materials and equipment shall be determined, with the approval of the Architect, as work progresses, to conform in the best possible manner with the surroundings and with the adjoining work of other trades. Where locations of equipment, devices or fixtures are controlled by architectural features, establish such locations by referring to dimensions on Architectural (A-series) drawings and not by scaling drawings.
- B. See plans for required coordination drawings and submittal process to engineer.

1.06 COORDINATION OF WORK

- A. Coordinate all work, prior to installation, with work of other trades and with architectural and structural features to preclude interferences between the work of different trades and to insure necessary clearances at crossovers and equipment. Work requiring necessarily fixed locations (e.g.: piping with required slopes, lighting fixtures and diffusers in ceilings, etc.) takes precedence over work not requiring such fixed locations and shall establish permissible routing of services associated with the latter. Should work be performed without adequate coordination so that interferences occur between work of different trade, the Contractor shall eliminate such interferences by requiring necessary re-work by the trades involved. Such re-work shall meet express approval of the Engineer and shall be performed at no addition to contract amount.

1.07 DISCREPANCIES

- A. In case of differences between drawings and specifications, or where drawings and specifications are not clear or definite, the subject shall be referred to Architect for clarification and instructions as RFI before bidding.
- B. Upon Contractor bidding approval, Contractor is automatically in agreement on the whole project as a workable and function entity as intended. Any necessary unaddressed items on the design shall be installed to assure workability and functionality of the system as a whole as part of the contract.

1.08 SHOP DRAWINGS

- A. Submit for approval, before commencing work, shop drawings for all mechanical materials and equipment to be provided under this contract. In addition, submit other drawings or diagrams, dimensioned and in correct scale, requested by the Architect to clarify the work intended or to show its relationship to adjacent work or work of other trades. Contractor is responsible for any delays in job progress accruing directly or indirectly from late submissions of shop drawings. Shop drawings shall clearly show the following:
1. Technical and descriptive data in detail equal to or greater than the data given in the item specification. Indicate all characteristics, special modifications and features. Where performance and characteristic data is shown on the drawings or specified, submitted data shall be provided in a degree which is both quantitatively and qualitatively equal to that specified and shown so that comparison can be made. Present data in detail equal to or greater than that given in item specification and include all weights, deflections, speeds, velocities, pressure drops, operating temperatures, operating curves, temperature ranges, sound ratings, dimensions, sizes, manufacturer's names, model numbers, types of material used, operating pressures, full load amperages, starting amperages, fouling factors, capacities, set points, chemical compositions, certifications and endorsements, operating voltages, thicknesses, gauges, and all other related information as applicable to particular item.
 2. Exceptions to or deviations from the contract documents: Should Architect approve any items having such deviations which are not clearly brought to Architect's attention, in writing, on item submittal, then Contractor is responsible for correction of such deviations regardless of when such deviations are discovered.

3. Stamp: Indicate on each shop drawing that Contractor has checked that same complies with the drawings and specifications by affixing a stamp indicating the following: Date, specification page and Section, drawing note indicating that manufacturer is to be approved as "or equal", and signature of person reviewing shop drawing. Stamp shall provide space for Architect's approval and date of approval.
- B. See specific Sections of the Specifications for any additional requirements.

1.09 TECHNICAL INFORMATION BROCHURE

- A. Submit within thirty days after Notice to Proceed. Each brochure shall consist of an electronic PDF file. Provide correct designation on outside cover and spine of binder, i.e.: MECHANICAL. All shop drawings shall be submitted at one time; partial submittals will not be accepted. Provide print copy if requested.
- B. First sheet in the brochure shall be a photocopy of the "Division 15000 Index" for these specifications. Second sheet shall be prepared by the Contractor and list Project addresses for this Project for Contractor and all major subcontractors and supplier.
- C. Provide an index with the appropriate specifications Section reference number and typed index for each Section.
- D. Shop drawing technical and descriptive data shall be inserted in the brochure in proper order on all items. Mark the appropriate specification Section or drawing reference number and drawing symbol in the right hand corner of each item. Provide complete information, including, but not limited to, wiring and control diagrams, scale drawings showing that proposed substitute equipment will fit into allotted space, (indicate all service access, connection, etc.) test data and other data required to determine if equipment complies fully with the specifications. All typewritten pages shall be on contractor or equipment manufacturer printed letterhead.
- E. Submit electronic brochures in PDF format. Each section shall be bookmarked in sequential order. Provide an electronic index to submission contents for the Owner, Architect, Engineer, Contractor, and Subcontractor.
- F. Contractor shall review the brochure before submitting. Submittal information on each item in each brochure shall bear the Contractor's stamp of approval, initials of checker and date checked by him. No request for payment of or substitutions will be considered until brochure has been reviewed by the Contractor and submitted for checking.

1.10 SHOP DRAWINGS FOR PIPING SYSTEMS AND DUCT SYSTEMS

- A. Shop drawings for piping systems and duct systems shall be provided electronically by the contractor and readily reproducible and shall be at 1/4" = 1'-0" scale to verify clearances and equipment locations. Shop drawings shall show all required maintenance and operational clearances required. Cost of shop drawing preparation and reproduction shall be borne by the Contractor. Title drawings shall include identification of project and names of Architect, Engineer, Contractor, Subcontractor and/or supplier, data number sequentially and shall indicate the following:
 1. Architectural and structural (as required) backgrounds with room names and numbers, etc., including, but not limited to, plans, sections, elevations, details, etc.

- a. Fabrication and erection dimensions.
 - b. Arrangements and sectional views.
 - c. Necessary details, including complete information for making connections with other work.
 - d. Kinds of materials and finishes.
 - e. Descriptive names of equipment.
 - f. Modifications and options to standard equipment required by the contract.
2. Leave blank area, size approximately 4 x 2-1/2", near title block (for Engineer's shop drawing stamp imprint).
- B. In order to facilitate review of drawings, insofar as practicable, they shall be noted, indicating by cross reference the contract drawings, note and /or specification paragraph numbers where item(s) occur in the Contract Documents.
- C. See specific Sections of specifications for further requirements.
- D. See plans for additional requirements.

1.11 PROCESSING OF SHOP DRAWINGS

- A. Product Data: For standard manufactured materials, products and items, submit in a single PDF file with all required forms included.
- B. Shop Drawings: and product data are to be sent to the Architect electronically.
 1. Shop drawings and submittals shall have a transmittal sheet attached.
 2. All submittals shall have the division number and cost code number on the transmittal sheet.
- C. Action Stamp: The Engineer will stamp each submittal with a uniform, action stamp. The Engineer will mark the stamp appropriately to indicate the action taken, as follows:
 1. Final Unrestricted Release: When the Engineer marks a submittal "No Exception Taken," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.
 2. Final-But-Restricted Release: When the Engineer marks a submittal "Furnish as Corrected," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.
 3. Returned for Resubmittal: When the Engineer marks a submittal "Revise and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - a. Do not use, or allow others to use, submittals marked "Not Approved, Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.
 4. Returned for Resubmittal: When the Engineer marks a submittal "Rejected," do not proceed with any work covered by this submittal, including purchasing,

fabrication, delivery or any other activity. This submittal does not comply with the Contract Documents or Specifications.

5. Restricted Release: When the Engineer marks a submittal "Submit Specifications," work covered by the submittal may proceed provided it complies with the Contract Documents and the Specifications are submitted for Engineer review.
 6. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Engineer will return the submittal marked "Action Not Required."
- C. Reference: "General Conditions of the Contract", or other similar contractual requirements.
- D. Contractor and applicable Subcontractor shall review the brochure before submitting to the Architect.
- E. Submittal information on each item in each brochure shall bear the Contractor's and Subcontractor's stamps of approval, initials of checkers and date checked.
- F. No request for payment of or substitutions will be considered until brochure has been reviewed by the Contractor and applicable Subcontractor and submitted for checking.
- G. Approval of shop drawings or other information submitted in accordance with the requirements herein before specified, does not assure that the Architect, or any Owner's Representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved, the ability of the material or equipment involved or the mechanical/electrical performance of equipment.
- H. Approval of shop drawings does not invalidate the plans and specifications if such approval creates a conflict, which would have not otherwise occurred. A letter requesting such change must be submitted and approval obtained on the Architect's letterhead.
- I. Timeliness of Submittals: Contractor is responsible for any delays in job progress accruing directly or indirectly from late submissions, required testing, or re-submissions of shop drawings, product data, or samples.

1.12 OTHER REQUIREMENTS

- A. Progress and Record Drawings
1. Keep two (2) sets of white prints on the job. Neatly mark-up design drawings with colored pencils each day as components are installed. Different colored pencils shall be used for different systems. Cost of prints shall be included under this Division. At the end of the project, all changes shall be transferred to a set of reproducible transparencies of the design drawings marked, "AS BUILT" and dated and stamped by the Contractor. Cost of the reproducible transparencies and of the drafting involved shall be included under this Division. Provide PDF copy of all completed record drawings with originals.
- B. Operating Instructions
1. Submit for checking a specific set of written operating instructions on each item which requires instruction to operate. After approval, insert information in each

Technical Information Brochure. Refer also to other Sections which may describe operating instructions.

- C. Maintenance Information
 - 1. Submit for approval Maintenance Information consisting of manufacturer's printed instructions and parts lists for each major item of equipment. After approval, insert information in each Technical Information Brochure. Refer also to other sections which may describe maintenance. Provide PDF copy with index. File must be searchable by major category of operation and properly bookmarked.
- D. Manufacturer's Check-Out
 - 1. Check out by Manufacturer's Representative (for major items of equipment): At completion of construction and after performance verification, information as above-mentioned has been gathered, submitted and approved, provide one (1) copy of this information to the manufacturer's representative. Work required under this Section shall include having the representative examine the performance verification information, check the equipment in the field while it is operating and sign a Check-Out Memo for record. Submit a copy of the memo and start-up report on each major item of equipment for each brochure. Approved memos shall be inserted on each brochure with the performance verification information and submittal data. Memos shall be submitted and approved before Instruction in Operation to Owner or a request for final inspection.
- E. System Guarantee
 - 1. The work required under this Division shall include a one-year guarantee. This guarantee shall be by the Contractor to the Owner to replace for the Owner any defective workmanship, equipment or material, which has been furnished under this Contract at no cost to the Owner, for a period of one year from the date of acceptance of the System. This guarantee shall also include reasonable adjustments of the system required for proper operation during the guarantee period. Explain the provisions of guarantee to Owner at the "Instruction in Operation Conference".
- F. Instruction To Owner
 - 1. Submit all required items for checking one week before final inspection of the building is scheduled. When all items are approved and placed in the proper brochures, the Contractor shall give notice in writing that he is ready to give the Owner an "Instruction in Operation Conference". After the above mentioned request is received, the Contractor will be notified of the time the conference can be held with the Owner. At the conference, the Contractor shall review with the Owner all appropriate information. At the end of the conference, seven (7) copies of a memo certifying "Instruction in Operation" and "Completed Demonstration", shall be signed by the Contractor, Subcontractor and Owner and one copy inserted in each brochure.
- G. Final Inspection
 - 1. Time Schedule for Final Inspection of System: All work on the system shall be complete and all forms and other information shall have been submitted for approval before the request for a substantial completion inspection is made.

1.13 SUBSTITUTIONS

- A. Each bidder represents that his bid is based upon the materials and equipment described in this Division of the specifications.
1. No substitutions will be considered unless a written request has been submitted to the Architect for approval twenty days prior to receipt of bids. Substitutions requested after that date will receive no consideration. Submittal shall include the name of the materials or equipment for which it is to be substituted, substituted equipment model numbers, drawings, cuts, performance and test data and any other data or information necessary for the Architect to determine that the equipment meets all specifications and requirements. If the Architect approves any proposed substitutions, such approval will be set forth in writing.
 2. Substituted equipment with all accessories installed or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems of this or other trades as a result of substitutions shall be made at the Contractor's expense and Contractor shall so state in his written request for substitution.
 3. Approved equal manufacturers or products may be provided elsewhere in these specifications and drawings. These are manufacturers or items which are known to be functionally equivalent to basis of design manufacturers and equipment. These alternatives are provided to produce a competitive bidding yielding a better value for the consumer. These items may and often do vary in specific characteristics, connections, and required services. The contractor remains liable and responsible for all coordination of other related systems, equipment, services, etc. E.G. (Substitution of approved equal Aaon air conditioning equipment in lieu of scheduled Addison equipment. Given that electric heat standard elements are not available in the exact increment required, compressor current varies, fan power varies. In this instance the mechanical contractor is responsible for coordinating changes of breaker and conductor size, possible distribution panel size and possible emergency power generator and distribution / transfer switch changes as well as possible changes to stored fuel capacity). This example lists a number of possible ramifications from utilizing other than the design basis equipment outside of changes to connection sizes and styles. These changes will need to be performed by the mechanical and other contractors or they will need to contract with the engineer(s) of record to provide new coordinated drawings. All of these associated costs for utilizing equipment not scheduled as basis of design are to be borne by the contractor.

PART 2 - ELECTRICAL AND MECHANICAL PROVISIONS AND COORDINATION**2.01 ELECTRICAL PROVISIONS**

- A. Work of Division 15000 shall include the electrical requirements which are indicated to be integral with mechanical work and which can be summarized to include (but not necessarily be limited to) the following:
1. Motors
 2. All motor starters (furnished by Division 15000, installed by Division 16000).
 3. Wiring from mechanical equipment to electrical work termination (junction box or disconnect switch.)
 4. Control switch, pilot lights, interlocks and similar devices.

5. Electrical heating coils and similar elements in mechanical equipment.
 6. Electrical work specified in Division 15000 for the HVAC control system.
 7. Drip pans to protect electrical work.
- B. Motors, Starters, Switches: Furnish with all motorized mechanical equipment unless otherwise indicated.
- C. Drip Pans: Where possible, do not run mechanical piping directly above electrical (or electronic) equipment which is sensitive to moisture; otherwise provide drip pans under mechanical piping. Locate pan below piping and extend 6" on each side of piping and lengthwise 18" beyond equipment. Fabricate pans 2" deep, of reinforced sheet metal with rolled edges and soldered or welded seams; 20 gauge copper, or 16 gauge steel with 2 oz. Zinc finish hot-dipped after fabrication. Provide 3/4" copper drainage piping, properly discharged.
- D. Motors: Unless specifically specified otherwise in the Section covering the driven equipment (or the equipment drives,) motors shall comply with the following:
1. Three Phase: NEMA design B, three-phase, squirrel cage induction type designed for 1800 rpm synchronous speed for operation in 40 degrees Celsius ambient at 1.15 service factor at constant speed on the scheduled voltage. Motors shall be insulated with Class B insulation material and be cast iron, drip proof, horizontal foot mounted type with ball bearings. Two speed motors shall be provided as scheduled and shall be two winding type.
 2. Single Phase: Squirrel cage induction type designed for 1800 rpm synchronous speed for operation in 40 degrees Celsius ambient at 1.15 service factor at constant speed on the scheduled voltage. Motors shall be insulated with Class B insulation materials and shall be two winding capacitor start type with steel enclosure, drip proof, horizontal foot mount and ball bearings.
 3. Electric motors which are designated to be high efficiency type shall also comply with the Section describing high efficiency motors.
 4. Motors 15 HP and above shall be arranged for Wye Delta start-run.
 5. See schedules for voltages.
- E. Scheduled Horsepower: The horsepowers scheduled or specified are those nominal sizes estimated to be required by the equipment when operating at specified duties and efficiencies. In the case of pumps, these horsepowers are non-overloading and may also include provisions for future planned impeller changes. If the actual horsepower for the equipment furnished differs from that specified or shown on the drawings, it shall be the Contractor's responsibility to insure that proper size feeders, breakers, starter, etc., are provided at no change in contract price. Contractor will coordinate with Electrical Contractor and adjust at no additional cost to Owner or Engineer.
- F. Voltage: The horsepowers scheduled or specified are those nominal sizes estimated to be required by the equipment when operating at specified duties and efficiencies. In the case of pumps, these horsepowers are non-overloading and may also include provisions for future planned impeller changes. If the actual horsepower for the equipment furnished differs from that specified or shown on the drawings, it shall be the Contractor's responsibility to insure that proper size feeders, breakers, starter, etc., are provided at no change in contract price. Contractor will coordinate with Electrical Contractor and adjust at no additional cost to Owner or Engineer.

- G. Any TEFC motors shall have Class F insulation.
- H. Drip proof protected motors shall have Class B insulation.
- I. Equipment suppliers shall furnish documentation certifying compliance with this Part 2 requirement of the specifications, at the time shop drawings are submitted for approval.
- J. All subsequent motor referrals in Division 15000 of these specifications shall comply with Part 2 of this Section.
- K. Approved electric motor manufacturers:
 - 1. Reliance Electric
 - 2. Gould Electric
 - 3. General Electric
 - 4. Westinghouse
 - 5. Baldor
 - 6. See Division 1 for prior approvals.

2.02 ELECTRICAL/MECHANICAL COORDINATION

- A. Definitions: Definitions for the purpose of mechanical/electrical control and power coordination are as follows: (Note: The use of the words, "provide", "furnish", and "install" are intended only for use in describing the coordination indicated by this paragraph 2.02 and do not necessarily have the same definitions when used outside of the context of this paragraph 2.02.) Any items which do not fall within the scope of this paragraph 2.02 shall be coordinated as individually specified.
 - 1. "Furnish" means to procure an item and to deliver it to the project for installation.
 - 2. "Install" means to determine (in coordination with others as necessary) the appropriate intended location of an item and to set and connect it in place.
 - 3. "Provide" means to both furnish and install.
 - 4. Power Circuit: Circuit which carries main electrical power to apparatus to which the power circuit is connected.
 - 5. Control Circuit: Circuit which carries electrical signals directing the performance of a controller, but which does not carry the main electric power. (See NEC, Section 430-71.) Such circuits shall also include those which serve a dual control and power function (e.g.: a line voltage thermostat circuit which both activates and powers a small fan motor.
 - 6. Controller: A device or group of devices, which serves to govern, in some pre-determined manner, electric power delivered to apparatus to which the controller is connected and includes any switch or device normally used to start and stop a motor. (See NEC, Article 100, Definitions, "Controller", and Article 430-81 (a).)
 - 7. Control Device: A device which reacts to an operating condition (pressure, temperature, flow humidity, etc.) and which initiates transmission of an electrical control signal which causes operation of a controller or which causes operation of pressure switches, etc.

8. Auxiliary Control Device: A device (such as a low voltage control transformer, electric relay, etc.) which is located in a control circuit and which carries or responds to (but does not initiate) an electrical control signal initiated by a control device.
- B. Work of Division 15000 includes, but is not necessarily limited to:
 1. Provide:
 - a. All controllers for Division 15000 electric motors.
 - b. All electric motors for Division 15000 equipment and other electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.) which are specified in Division 15000.
 - c. All control circuits, including conduit and box(es) from the Division 16000 panels to point of use including the necessary circuit breakers.
 - d. All other control circuits, including conduit and boxes.
 - e. All control connections to equipment.
 - f. All control connections to controllers, switches, motors and other mechanical systems electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.).
 - g. Auxiliary control devices
 - h. All control devices (thermostats, pressure switches, flow switches, humidistats, etc.) and make control circuit connections thereto.
 - i. Any and all pneumatic and electronic and electric control devices and electric or pneumatic connections thereto.
 - j. All low voltage conduits, conductors, boxes, etc.
 2. Install:
 - a. Duct mounted smoke detectors. (Furnished by Division 16000.)
- C. Work of Division 16000 includes, but is not necessarily limited to:
 1. Provide
 - a. All power circuits, including conduit and boxes.
 - b. All power connection to controllers, switches, motors and other mechanical systems electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.).
 - c. All remote motor disconnects (remote from the related controller) at all locations required by NEC and connections thereto except those disconnects which are specified in Division 15000 to be provided as part of the equipment itself.
 2. Furnish: (by Division 16000)
 - a. Duct mounted smoke detectors (installed by Division 15000.) wired by Division 16000.

2.03 ACCEPTABLE MANUFACTURERS

- A. Acceptable Manufacturers: Materials and Equipment specified in these contract documents are approved only in regards to general performance and quality. It shall be the Contractor's responsibility to insure that acceptable materials and equipment meet or exceed the efficiencies, capacities, electrical characteristics, performance and quality of the equipment herein specified. Acceptable equipment must also generally conform, without extensive modification of related systems to the accessories, weights, space and

maintenance requirements, etc., of the specified equipment. Any modification to the related systems of this or other trades shall be made at the Contractor's expense and the Contractor shall be responsible for coordination between trades. Any difference in capacity, efficiency, electrical characteristics, weights or quality of product, etc., between specified materials and equipment and acceptable alternates shall be submitted to the Architect for approval within 20 days of Notice to Proceed.

2.04 STARTERS

- A. All starters serving motors less than 15 HP shall be full-voltage, non-reversing and all starters serving motors 15 HP and above, shall be reduced voltage, wye delta, closed transition. Starters shall be sized for the load served and shall be minimum NEMA Size 1.
- B. All starters shall be in NEMA 1 enclosures unless installed in a damp area where NEMA 4X shall be used.
- C. All starters, if not free standing, shall be mounted in independent steel structural supports. Do not directly attach or thru-bolt through exterior wall panel systems.
- D. Unless specifically indicated otherwise, starters shall be equipped as follows:
 - 1. Cover mounted "Hand-Off-Automatic" selector switch, heavy duty, oil tight type with engraved label "Panel and Circuit Number".
 - 2. Cover mounted, RED (for stopped) and GREEN (for running) indicator lights, heavy duty, oil tight type.
 - 3. Control power transformer for 24 volt or 120 volt control if required. Provide CPT primary fuses.
 - 4. Two extra pair of contacts (two N.O. and two N.C.)
 - 5. Cover mounted Start-Stop push button, heavy duty, oil tight type with engraved label, "Panel and Circuit Number".
 - 6. Integral fused (as required by manufacturer of equipment being served) disconnect switch as required by NEC for accessibility/visibility as the motor safety disconnect with within 3'-0" of the motor or equipment served.
 - 7. Undervoltage protection if starter is interlocked with a maintained contact control device such as a float switch or pressure switch.
 - 8. Single phase protection (all motors).
- E. Starters shall be manufactured by:
 - 1. General Electric
 - 2. See Division 1 for prior approval.

PART 3 - SPECIAL REQUIREMENTS

3.01 AUXILIARIES AND ACCESSORIES

- A. Include all auxiliaries and accessories for complete and properly operating systems. Any condition not noted will be considered as part of this Contractor's responsibility and at no additional cost to Owner or Engineer.

3.02 INVESTIGATION OF SITE

- A. Check site and existing conditions thoroughly before bidding. Advise Architect of discrepancies or questions noted before bidding.

3.03 COORDINATION

- A. Provide all required coordination and supervision where work of this division connects to or is affected by work of others.

3.04 PROVISIONS FOR OPENINGS

- A. Provide all openings required for work performed under this section. Provide sleeves or other approved methods to allow passage of items installed under this Section.

3.05 INTERRUPTIONS OF EXISTING SERVICES

- A. Any interruption of existing services shall be coordinated in advance with the Owner's Representative. Shutdown time and duration of critical services shall be decided by the Owner. Contractor shall provide shutoff valves at point of tie-in to minimize downtime.

3.06 SUPERVISION OF THE WORK

- A. Provide a field superintendent who has had previous successful experience on projects of comparable size and complexity to direct the proper and prompt execution of the work. Superintendent shall be present at all times that work is being installed. Superintendent shall not be removed from the project without written notification to the Architect.
- B. Reports on Progress of Work Memo:
 - 1. Items noted during construction and before final acceptance which do not comply with the Contract Documents will be listed in a "Report on Progress of the Work" memo, which will be sent to the Contractor for action.
 - 2. The Contractor shall have these items corrected and shall sign and enter the date on which the item was corrected on two copies of the memo as indication that the item has been corrected and return the signed memos so items can be rechecked. Failure to return the signed memos shall be cause for disallowing monthly request for payments.
 - 3. Items noted after acceptance during one year guarantee period shall be checked by the Contractor in the same manner as above and the signed memos returned by him when the items have been corrected.

3.07 CLEANING AND PROTECTION

- A. Ductwork and Equipment: Keep equipment and the interior of the duct system free from dirt and rubbish and other foreign matter. All fan motors, switches and other items, shall also be protected from dirt, rubbish and other foreign matter during building construction. Thoroughly clean all components of the ductwork and remove all dirt, scale, oil and other foreign substances, which may have accumulated during the installation process.
- B. Equipment: All mechanical equipment provided shall be thoroughly cleaned of all dirt, oil, concrete, etc. Any dents, scratches or other visible blemishes shall be corrected and the appearance of the equipment made "like new" and to the satisfaction of the Architect.

- C. Upon completion and before final acceptance of the Work, all debris, rubbish, leftover materials, tools and equipment, shall be removed from the site.
- D. Protection of Work Until Final Acceptance: Contractor shall protect all materials and equipment from damage and the entrance of dirt and construction debris from the time of installation until final acceptance. Any materials and equipment that has been damaged, shall be repaired to "as new" condition or replaced at the direction of the Architect. Where factory finishes occur and damage is minor, finishes may be touched up. If, in the opinion of the Architect, the damage is excessive, factory finish shall be replaced to "new" condition.

END OF SECTION

SECTION 15015**SLEEVES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. The requirements of Section 15000 – Supplemental Provisions – Mechanical, apply to this Section.
- C. Reference Sections: Section 15000: General Mechanical Provisions, Cutting and Patching.

1.02 DESCRIPTION OF WORK

- A. This Contractor shall provide sleeves for his work.
- B. Furnish sleeves for all round openings through new masonry and concrete construction above grade. Holes through existing masonry or concrete construction shall be core drilled.
- C. Use sleeves where round or oval duct openings are required through exposed walls, smoke or fire walls, and equipment room walls.
- D. Use sleeves where round piping openings are required through exposed walls, smoke or fire walls, and equipment room walls.
- E. This Contractor is responsible for correct locations, size, and delivery of the sleeves.

PART 2 - PRODUCTS**2.01 SLEEVE MATERIAL**

- A. Sleeves up through 8" diameter shall be Schedule 40 steel pipe and machine cut, as specified below.
- B. Sleeves, 10" diameter and larger, shall be furnished from 12 gauge steel sheet.
- C. No plastic PVC is permitted unless noted otherwise.

2.02 WATERTIGHT SEALS

- A. "Linkseal", by Thunderline Corporation. Provide correct sleeve size.

PART 3 - EXECUTION**3.01 SLEEVE INSTALLATION**

- A. Size sleeves shall provide 1/2" minimum clearance all around passing pipe or pipe insulation. Insulation shall be continuous through sleeves.
- B. Fill space around ducts and pipes in sleeves in exposed areas and through fire walls and partitions with non-flammable sealing compound equal to Dow Corning Silicone RTV Foam.
- C. Close off all spaces around rectangular ducts through walls with sheet metal collars.
- D. Sleeves through walls shall be cut flush with each surface.
- E. Install sleeves plumb and true to line, grade and position.
- F. Unused sleeves shall be plugged and finished to match adjacent surface.
- G. Pipe sleeves penetrating outside walls shall be packed with insulating material, sealed and made waterproof. Option: Watertight seals specified above.

END OF SECTION

**SECTION 15020
HANGERS AND SUPPORTS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. The requirements of Section 15000 – Supplemental Provisions, Mechanical, apply to this Section.

1.02 DESCRIPTION OF WORK

- A. Provide supports and hangers for all piping and piping system components.
- B. Provide supports and hangers for all equipment.
- C. Provide steel angles and channels between structural members as necessary to support piping and equipment.

1.03 RELATED SECTIONS

- A. Section 15025: Installation of Piping.
- B. Section 15000: Supplemental Provisions – Mechanical.

1.04 QUALITY ASSURANCE

- A. Requirements of the latest revision of the Florida Building Code and Florida Mechanical/Plumbing Code.
- B. Meet the requirements of the following:
 - 1. MSS SP 58 Pipe Hangers and Supports.
 - 2. ANSI Code for Pressure Piping
 - 3. Hangers and supports shall have a stress safety factor of five (5).
 - 4. Latest revision of the Florida Building Code.
 - 5. ASTM, UL, NFPA.

1.05 SUBMITTALS

- A. Submit manufacturer's product data for the following:
 - 1. Hangers
 - 2. Supports
 - 3. Inserts

1.06 COORDINATION

- A. Obtain Engineer approval before welding, drilling or cutting any structural members.
- B. Coordinate runs of piping and locate equipment to utilize structural members.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Products are based on Grinnell as basis of design.
- B. Approved Manufacturers:
 - 1. Anvil International
 - 2. Cooper B-Line, Inc F & S
 - 3. Mason Industries
 - 4. Michigan
 - 5. See Division 1 for prior approvals.

2.02 STRUCTURE ATTACHMENT DEVICES

- A. Riser clamp, steel: Grinnell Fig. 261. Provide masonry or concrete bearing.
- B. Riser clamp, copper: Grinnell Fig. CT-121, copper plated. Provide masonry or concrete bearing.
- C. Top beam clamp: Grinnell Fig. 227 with Fig. 157 extension.
- D. Bottom beam clamp: Grinnell Fig. 229. (Use only where top clamps are not possible. Obtain approval from Engineer.)
- E. Side beam bracket: Grinnell Fig. 202. (For wood construction only.)
- F. Horizontal traveler: Grinnell Fig. 170
- G. Concrete inserts: Grinnell Fig. 282, galvanized.
- H. Concrete fasteners: Phillips "Red Head".
- I. Copper tube strap: Grinnell Fig. 9124.
- J. Pipe strap: Grinnell Fig. 153.
- K. Pipe hanger flange: Grinnell Fig. 153.
- L. Bottom channel clamp: Grinnell Fig. 226 with 157 extension. (Obtain approval from Engineer prior to use.)
- M. Bottom beam/joist C clamp: Grinnell Fig. 87 with retaining clip and locknut. (Obtain approval from Engineer prior to use on pipes 2" or smaller.)

2.03 HANGERS AND ACCESSORIES

- A. Adjustable copper tubing ring: Grinnell Fig. CT-99, copper plated.
- B. Adjustable swivel split ring: Grinnell Fig. 104, black finish.
- C. Adjustable pipe ring, plastic coated: Grinnell Fig. CT-99c, plastic coated.
- D. Heavy adjustable clevis: Grinnell Fig. 260, black finish.

- E. Lightweight adjustable clevis: Grinnell Fig. 65, black finish.
- F. Pipe roll stand (base supported): Grinnell Fig. 271, cast iron roll.
- G. Adjustable pipe roll: Grinnell Fig. 181.
- H. Pre-engineered spring hanger: Grinnell Figs. B-268, 82, or 98.
- I. Insulated pipe saddle: Hot lines – high density pre-compressed fiberglass support segment with 18 gauge galvanized steel shield. Cold lines – provide “Foamglass” pipe insulation with jacket and 18 gauge galvanized steel shield. Insulation thickness shall be same as specified in 15900.

2.04 HANGER RODS AND ACCESSORIES

- A. Provide plated steel threaded rods. Size according to 3.2 following.
- B. Provide all necessary couplings, turn buckles, nuts, washers, and accessories for a complete installation.

2.05 TRAPEZE COMPONENTS

- A. Horizontal Trapeze Member: Unistrut P-2700 series channel, standard or heavy duty according to load.
- B. Trapeze Clamp: Unistrut two-piece bolted pipe clamp; steel for steel pipes, copper for copper pipes.

2.06 EQUIPMENT SUPPORTS

- A. Provide 3 x 3 x 1/4 angles or heavier, if required, spanning 3 structural joints to support hung equipment.
- B. Provide channels (strength as required) to span between beams. Weld to beams. Obtain approval of Engineer before proceeding.

PART 3 - EXECUTION

3.01 PIPE SUPPORT METHODS

CONDITION	SUPPORT METHOD
Uninsulated copper pipe horizontal, hung	Adjustable copper tubing ring and hanger rod
Uninsulated copper pipe horizontal, bottom support	Copper tube strap. Provide necessary angle braces.
Uninsulated copper pipe vertical	Copper tube strap to walls with anchors. Riser clamp, copper at floors
Uninsulated steel pipe horizontal, hung	Adjustable swivel split ring and hanger rod (sizes to 8"); heavy adjustable clevis and hanger rod (sizes to 10" and larger).
Uninsulated steel pipe horizontal, hung, with movement	Adjustable pipe roll hanger and rod.

CONDITION	SUPPORT METHOD
Uninsulated steel pipe horizontal, bottom support	Pipe roll stand.
Uninsulated steel pipe vertical	Pipe strap to walls. Riser clamp at floors.
Uninsulated metal drain pipe horizontal, hung	Heavy adjustable clevis, hanger rod.
Uninsulated metal drain pipe vertical	One hole clamp at walls. Riser clamp, steel at floors.
Insulated pipe horizontal, bottom support	Insulated pipe saddle, pipe roll stand.

B. Notes:

1. Install pipe saddles as pipe is installed
2. Trapeze hangers may be used for multiple horizontal hung pipe runs. Trapeze consists of hanger rods, horizontal trapeze member, and trapeze clamps. Each pipe individually attached to trapeze.
3. Hangers shall be isolated from dissimilar metals or materials with di-electric fittings.

3.02 SUPPORT SPACING AND HANGER ROD DIAMETERS

A. Cast iron, ductile iron, steel and copper pipes:

PIPE SIZE	MAXIMUM VERTICAL AND HORIZONTAL SUPPORT SPACING	ROD DIAMETER
1/2", 3/4"	5'	3/8"
1", 1-1/4"	6'	3/8"
1-1/2", 2"	9'	3/8"
2-1/2", 3"	11'	1/2"
4", 5"	12'	5/8"
6", 8"	12'	3/4"
10"	12'	7/8"
12" through 24"	12'	1"
30"	12'	1-1/8"

B. Notes:

1. Maximum support spacing for horizontal cast iron drain and vent lines is one support at each joint. (i.e., 5' spacing for 5' lengths, 10' spacing for 10' lengths).
2. Provide additional supports at turns, valves, concentrated loads connections to equipment, and, where necessary, for proper alignment.

3.03 STRUCTURE ATTACHMENT METHODS

CONDITION	SUPPORT METHOD
Hanger rod to steel bar or truss	Top beam clamp.
Hanger rod to steel beam (corrugated metal deck above)	Top beam clamp.
Hanger rod to steel beam (concrete deck above, temporary form.	Bottom beam clamp.
Hanger rod to pre-cast or existing concrete deck.	Concrete fasteners, pipe hanger flange.
Hanger rod to new cast-in-place concrete deck.	Concrete insert.
Hanger rod to wood beam.	Side beam bracket, lag bolt to beam (use bolt through entire beam when load exceeds manufacturer's recommended load for lag bolt application.)
Hanger rod to any structure at elbows with significant lateral movement.	Horizontal traveler.
Hanger rod to any structure at risers with significant vertical movement.	Pre-engineered spring hanger.
Hanger rod to any structure at risers from vibrating equipment.	Pre-engineered spring hanger.

B. Notes:

1. Do not install hangers from metal roof deck.
2. Avoid drilling concrete by using inserts.
3. Explosive powder driven fasteners are not allowed.
4. Weld to steel structural members. In wood construction: Where pipe is parallel to, and hanging from joists, rafters, or beams, bolt angles to side of members vertically, bolt horizontal angles to side of members vertically, bolt horizontal angles to vertical angles, attach hanger rods to horizontal angles. Consult with Engineer and affected trades regarding procedure.
5. Vertical piping shall be anchored to building with two point bearing.

3.04 VIBRATING EQUIPMENT

- A. In-line fan support: Contractor shall provide a calibrated spring-hanger, approved by the fan manufacturer. The spring shall support the fan at approximately the center of gravity and shall reduce the piping load to less than 10% of the weight of the pump at room temperature.
- B. Support piping at fans and equipment from floor, ceiling or walls, so that piping weight is not supported from fans or equipment.

3.05 WET AREA AND EXTERIOR SUPPORTS

- A. Use non-ferrous, galvanized steel, plated steel or plastic coated steel supports and hangers in exterior applications.

3.06 ADDITIONAL REQUIREMENTS

- A. Properly support pipe to maintain required alignment, slopes, and expansion capabilities.
- B. Piping shall be supported independently from the building structure. Where interferences occur, provide trapeze type hangers or other suitable supports for each system. Locate hangers and supports where they will not interfere with access to valves and other appurtenances requiring service.
- C. Whenever mechanical equipment rooms are located within or immediately adjacent to the occupied building, vibration dampening hangers and supports shall be used.

END OF SECTION

**SECTION 15025
INSTALLATION OF PIPING**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. The requirements of Section 15000 Supplemental Provisions, Mechanical apply to this Section.

1.02 DESCRIPTION OF WORK

- A. Install above ground piping as specified below.
- B. Refer to other Sections of Division 15000 for additional requirements.

1.03 QUALITY ASSURANCE

- A. Requirements of the latest revision of the Florida Building Code and Florida Building Code, Mechanical and Plumbing.

PART 2 - PRODUCTS**2.01 UNIONS**

- A. Unions in copper pipe: Bronze 150# ground joint, solder end. Mueller, Chase or Nibco.
- B. Unions in steel pipe: Black malleable iron, bronze ground ball joint. Mueller, Chase or Nibco.
- C. Dielectric unions:
 - 1. Capitol
 - 2. Dart
 - 3. Vogt
 - 4. See Division 1 for prior approvals.

2.02 VALVES

- A. Drain valves: 3/4" bronze or brass hose and gate, Powell 503 HS where exposed; Powell 502 HS with cap and chain where concealed.
- B. Flanged joints of valves: Spirotallic-Condren #913, type 304 stainless steel with carbon steel guide, 150# flanges.

2.03 NIPPLES

- A. Nipples shall be same weight and material as pipe in which they are installed.
- B. Close and shoulder nipples shall be extra heavy.

PART 3 - EXECUTION**3.01 PIPING INSTALLATION**

- A. Cut pipe accurately, remove burrs by reaming, and work into place without forcing or springing.
- B. Use pipe lubricant on male threads only. Teflon pipe joint tape may be used.
- C. Make all changes of direction with fittings, rather than bending.
- D. Install piping level, except where specifically required to pitch. Arrange piping to allow draining the entire system.
- E. Use eccentric reducers, keeping top of pipe level in water systems and the bottom of pipe level in steam and condensate systems.
- F. Bull head connections in any piping service are expressly prohibited.
- G. All piping shall be installed in a neat and workmanlike manner and parallel to building walls.
- H. Properly support all relief valve discharge piping. No pipes shall cross over or within 3'-0" of electrical panels.
- I. Condensate piping shall be pitched a minimum of 1/8" per foot and cleanouts provided at every 90 degree bend and at convenient intervals in straight lines. A trap shall be provided at each equipment connection to drain. Water seal must exceed maximum pressure developed by the equipment.

3.02 VALVES AND SPECIALTIES

- A. Install with handwheel at or above center line of pipe.
- B. Install with union downstream of valve.
- C. Install with sweat adapters upstream of valve.
- D. Install where accessible.
- E. Provide drain valve at low points in piping.
- F. Install the thermometers and gauges to be readable from the floor.
- G. Blow down valves and strainers shall be installed to allow removal of strainer baskets and servicing.
- H. Install air vents at all highpoints, piping drops and other points where necessary for air removal.

3.03 ESCUTCHEONS

- A. Provide chrome plated escutcheons for exposed piping passing through walls, floors and ceilings or finished areas.
- B. Protect from tool marks.

3.04 UNIONS AND FLANGES

- A. Flanged joints shall be faced true and square, and gasketed for proper seal.
- B. Provide unions or flanges at all connections to equipment and fixtures to facilitate removal and servicing.
- C. Provide dielectric unions or flanges between dissimilar metals, such as copper to steel.
- D. Install where accessible.

3.05 COORDINATION

- A. Drawings are schematic. Contractor is responsible for correct connections.
- B. Where interferences develop, piping shall be offset or re-routed to clear interferences.
- C. Where piping is installed in accessible chases, keep all piping to sides of chase, except portions which must necessarily be in the center of chase. Offset vents to side immediately above connection to waste line.
- D. Piping shall be concealed except in unfinished rooms and except as shown.

3.06 EXPANSION CONTROL

- A. Install piping to permit free expansion and contraction without damage to joints and hangers.
- B. Provide pipe loops or offsets in dual temperature supply and return lines where required or necessary for accurate control of movement.
- C. Pipe branches from mains must incorporate at least one change of direction in horizontal plane, and one change of direction in vertical plane, before connecting to equipment or fixtures, unless main is anchored at branch take-off.
- D. Install flexible connections to vibrating equipment.
- E. Provide securely supported pipe anchors and guides where required or necessary to control expansion and contraction of piping.

3.07 WELDING

- A. Submit to Owner two (2) copies of Contractor Welding Procedure Specifications, Procedure Qualification Records, and the Manufacturer's Record of Welder or Welding Operator Qualification Tests meeting the requirements of ASME Boiler Tests meeting the requirements of the ASME Boiler and Pressure Vessel Code, Section IX, and obtain written approval before performing any welding.
- B. Welding and non-destructive examination shall meet the requirements of ANSI B31.1, Power Piping, latest edition.
- C. Provide safety barriers and fireproof clothes to protect personnel and materials near welding operations.

END OF SECTION

**INSTALLATION OF PIPING
SECTION 15025 – 3**

10/12/2017

**SECTION 15040
SERVICE IDENTIFICATION**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. The requirements of Section 15000 Supplemental Provisions, Mechanical, apply to this Section.

1.02 DESCRIPTION OF WORK

- A. Provide pipe identification for all exposed piping in Mechanical Equipment Rooms, on main lines above accessible ceilings, access panels, and piping exposed to view.
- B. Provide valve tags for all valves.
- C. Provide equipment nameplates for all major mechanical equipment, such as chillers, boilers, pumps, air handling units, fan coils, etc.

1.02 QUALITY ASSURANCE

- A. Requirements of the latest revision of the Florida Building Code and Florida Mechanical/Plumbing Code.
- B. Meet the requirements of:
 - 1. ANSI A13.1-1981 – Scheme for the Identification of Piping Systems.
 - 2. ANSI 253.1 – Safety Color Code for Marking Physical Hazards.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Pipe markers shall be "SET MARK" semi-rigid plastic identification markers as manufactured by Seton Name Plate Corporation. Markers shall conform to ANSI A13.1 for correct color background, color of letters and correct marker length. Use Type STR markers on outside diameters of 3/4" through 5", and Type STR markers on outside diameters of 6" and larger. Direction of flow arrows shall be included on each marker. Letter height and length of color background shall be as follows:

OUTSIDE DIAMETER	LETTER HEIGHT	LENGTH OF COLOR FIELD
3/4" – 1-1/4"	1/2"	8"
1-1/2" – 2"	3/4"	8"
2-1/2"-6"	1-1/4"	12"
8"-10"	2-1/2"	24"
OVER 10"	3-1/2"	32"

- B. For pipes less than 3/4" O.D., a permanently legible tag shall be used.
- C. Valve tags shall be 1-1/2" diameter, 19 gauge brass attached with copper meter seal wire, brass chain, or "S" hook. Service designation letter shall be 1/4" high minimum and black filled. Valve numbers shall be 1/2" high and black filled. Stamp tags with service designation and number consecutively for each system – Style 250-BL.
- D. Equipment name plates shall be 1-1/2" x 4" aluminum with black enamel background and with the equipment designation engraved in natural aluminum lettering not less than 1/2" high.

2.02 MANUFACTURERS

- A. Model numbers of Seton Name Plate Corporation, New Haven, CT are used as standard.
- B. Approved manufacturers.
 - 1. W.H. Brady
 - 2. See Division 1 for prior approvals.

2.03 SUBMITTALS

- A. Submit manufacturer's product data for tags and identification with colors and wording indicated.

PART 3 - EXECUTION

3.01 PIPE IDENTIFICATION (Use colors for services that apply to this project.)

TYPE OF SERVICE	BACKGROUND COLOR	LETTER COLOR	SERVICE DESIGNATION
Domestic Cold Water	Green	White	Cold Water
Domestic Hot Water	Green	White	Hot Water
Domestic Hot Water	Green	White	Hot Water Return
Gas (Natural)	Yellow	White	Gas
Compressed Air	Yellow	Black	Compressed Air
Fire Protection Water	Red	White	Fire Water
Condensate	Green	White	Condensate
Refrigerant Hot Gas	Blue	White	Refrigerant Hot Gas
Refrigerant Liquid	Blue	White	Refrigerant Liquid
Suction	Blue	White	Suction
Oxygen	Yellow	Black	Oxygen

3.02 INSTALLATION

- A. Pipe markers:
 - 1. Service designation shall be readable from a standing position from the floor.
 - 2. Provide pipe markers at 25ft. maximum intervals on mains above ceilings.
 - 3. Provide markers at each major branch from mains and at each branch in mechanical rooms.
 - 4. Provide a marker at each equipment connection.

B. Valve tagging:

1. Attach tags to valve handles in such a manner that valve shall be operable without damaging or removing tag.
2. Prepare valve charts showing tag number, locations, sizes, and services. Frame under glass and mount in equipment room. A copy of chart shall be included in the service manual. Follow sample valve chart heading.

TAG NUMBERS	LOCATION	SERVICES
V-1	Cooling Tower Supply	Shuts off Cooling Tower Supply

C. Equipment nameplates:

1. Nameplate designation shall consist of unit number and area served.
2. Locate nameplates where readable from a standing position on the floor.
3. Secure nameplates securely with rivets or screws.

END OF SECTION

**SECTION 15060
PIPE, TUBE AND FITTINGS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. This section is a Division 15000 Basic Materials and Methods Section, and is a part of each Division 15000 section making reference to pipe, tube, and fittings specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of pipe, tube, fittings required by this section is indicated on drawings and/or specified in other Division 15000 sections. Drawings are diagrammatic only and do not indicate every bend, fitting, etc. required for installation in the space allotted. Coordinate the work of this section with other work to avoid conflicts.
- B. Types of pipe, tube, and fittings specified in this section include the following:
 - 1. Piping Materials:
 - a. Steel Pipe
 - b. Copper Tube
 - c. Cast-Iron Soil Pipe
 - d. Acid-Resistant Pipe
 - e. Underground PVC Pipe and Fittings
 - f. CPVC Pipe and Fittings
 - 2. Pipe/Tube Fittings:
 - a. Fittings for Steel Pipe
 - b. Fittings for Copper Tube
 - c. Fittings for Cast-Iron Soil Pipe
 - d. Fittings for Acid-Resistant Pipe
 - e. Fittings for PVC Pipe
 - 3. Grooved Piping Products
 - 4. Miscellaneous Piping Materials/Products
- C. Pipe, tube, and fittings furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division 15000 sections.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of pipe, tube, and fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Welding: Qualify welding procedures, welders and operators in accordance with ANSI B31.1, paragraph 127.5, for shop and project site welding of piping work.
 - 1. Certify welding of piping work using the Standard Procedure Specifications by, and welders tested under supervision of, the National Certified Pipe Welding Bureau (NCPWB). Applicable for boilers and high pressure steam piping only.

- C. Brazing: Certify brazing procedures, brazers, and operators in accordance with ANSI B31.5, paragraph 527.5 for shop and job-site brazing of piping work.
- D. NSF Labels: Where plastic or fiberglass piping is indicated to transport potable water, provide pipe and fittings bearing approval label by National Sanitation Foundation (NSF).

1.04 SUBMITTAL

- A. Product Data: Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of pipe, tube, and fitting. Submit piping schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.
- B. Welding Certifications: Submit reports as required for piping work.
- C. Brazing Certification: Submit reports as required for piping work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Except for hub-and-spigot and similar units of pipe, provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.
- B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.
- C. Protect flange and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. General: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
- B. Steel Pipe (Schedule 40):
 - 1. Black Steel Pipe: ANSI/ASTM A 53, A 106 or A 120; except comply with ANSI/ASTM A 53 where close coiling or bending is required.
 - 2. Galvanized Steel Pipe: ANSI/ASTM A 53 or A 120; except comply with ANSI/ASTM A 53 where close coiling or bending is required.
 - 3. Seamless Steel Pipe: ANSI/ASTM A 53, A 106 or A 120; except comply with ANSI/ASTM A 53 or A 106 where close coiling or bending is required.
 - 4. Galvanized Seamless Steel Pipe: ANSI/ASTM A 53 or A 120; except comply with ANSI/ASTM A 53 where close coiling or bending is required.
 - 5. Electric-Resistance-Welded Steel Pipe: ANSI/ASTM A 135.
 - 6. Electric-Fusion-Welded Steel Pipe: ANSI/ASTM A 671, A 672, or A 691.
 - 7. Alloy Steel Pipe: ANSI/ASTM A 333.
 - a. Grade: Provide Grade 9, except as otherwise indicated.

8. Steel Water Pipe: ANSI/AWWA C200 for pipe 6" and larger.
- C. Copper Tube:
 1. Copper Tube: ANSI/ASTM B 88; Type "L" as indicated for each service; hard-drawn temper, except as otherwise indicated.
 2. ACR Copper Tube: ANSI/ASTM B 280.
- D. Cast-Iron Soil Pipe:
 1. Hubless Cast-Iron Soil Pipe: CISPI 301; include coupling assembly. Gaskets shall conform to ASTM C 564.
 2. Cast-Iron Hub-and-Spigot Soil Pipe: ANSI/ASTM A 74. Gaskets shall conform to ASTM C 564.
- E. Acid-Resistant Pipe:
 1. Plastic Pipe: Flame retardant polypropylene conforming to ASTM D2146/D648. Pipe shall conform to ASTM D1785 for Schedule 40 pipe. Flammability shall meet ASTM D635 and smoke density shall meet ASTM D2843.
- F. Drainage Pipe:
 1. Perforated Polyvinyl Chloride Pipe (PVC): ANSI/ASTM D 2729; perforated except where standard sections of pipe are indicated.
- G. Underground PVC Pipe:
 1. PVC Pipe shall be SDR-14 Schedule 80, Class 200 and meet the requirements of AWWA C900, having elastomeric gasket bell ends and elastomeric seals. Pipe shall be furnished in standard 20-foot lengths. Pipe shall bear the National Sanitation Foundation seal for potable water pipe and shall be marked with SDR and Class Number
 2. The joints for PVC water pipe shall be rubber ring type consisting of integral, thickened, solid wall bells which maintain the same D.R. as the pipe barrel. Joint lubrication shall be as furnished by the manufacturer of the pipe and joints made in accordance with the manufacturer's instructions and recommendations. Pipe specified shall be Blue-Brute as manufactured by Johns-Manville.
- H. Domestic Hot & Cold Water Piping:
 1. Schedule 40 CPVC for pressure 80 psi or less.
 2. Type "L" copper for pressure exceeding 80 psi and/or
 3. Return air plenum ceiling air conditioning system.
 4. All domestic water piping and valves to be Lead Free.

2.02 PIPE/TUBE FITTINGS

- A. General: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.
- B. Fittings for Steel Pipe:
 1. Cast-Iron Flanged Fittings: ANSI B16.1, including bolting.
 2. Cast-Iron Threaded Fittings: ANSI B16.4.

3. Malleable Iron Threaded Fittings: ANSI B16.3; plain or galvanized as indicated.
 4. Full Flow Ductile Iron Grooved Fittings: ASTM A 536, for grooved piping systems.
 5. Malleable Iron Threaded Unions: ANSI B16.39; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.
 6. Threaded Pipe Plugs: ANSI B16.14.
 7. Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
 - a. End Connections: Butt welding.
 - b. Facings: Raised-face.
 8. Steel Pipe Flanges for Waterworks Service: ANSI/AWWA C207.
 9. Corrosion-Resistant Cast Flanges/Fittings: MSS SP-51, including bolting and gasketing.
 10. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe.
 11. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.
 12. Cast-Iron Threaded Drainage Fittings: ANSI B16.12.
 13. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.
 14. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1½", and do not thread nipples full length (no close-nipples).
- C. Fittings for Copper Tube:
1. Cast-Copper Solder-Joint Fittings: ANSI B16.18 for pressure piping.
 2. Wrought-Copper Solder-Joint Fittings: ANSI B16.22
 3. Cast-Copper Solder-Joint Drainage Fittings: For solvent drainage systems, ANSI B16.32.
 4. Cast-Copper Flared Tube Fittings: ANSI B16.26.
 5. Bronze Pipe Flanges/Fittings: ANSI B16.24.
 6. Non-Ferrous Pipe Flanges: ANSI B16.31.
 7. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.
- D. Fittings for Cast-Iron Soil Pipe:
1. Hubless Cast-Iron Soil Pipe Fittings: CISPI 301; and complying with governing regulations.
 2. Coupling: Heavy duty, wide Type 304 stainless steel housing, guides and bolts with interlocking neoprene gasket.
 3. Cast-Iron Hub-and-Spigot Soil Pipe Fittings: Match soil pipe units; complying with same standards (ANSI/ASTM A 74).
 4. Compression Gaskets: CISPI Standard HSN.
 5. Lead/Oakum Joint Materials: Provide products complying with governing regulations for use in service indicated.

- E. Fittings for Acid-Resistant Pipe:
 - 1. General: Provide fittings matching pipe, and with equal-or-better acid resistance; comply with same standards where applicable. Unless otherwise indicated, provide fittings produced by manufacturer of pipe, and recommended for service indicated.
 - a. Plastic Pipe: Flame retardant polypropylene capable with fusion seal pipe. Fittings shall be joined by use of integral electrical resistance coils energized by a low voltage power supply. P-traps shall have mechanical joint connections.
- F. Fittings and Accessories for Drainage Pipe:
 - 1. General: Unless otherwise indicated, provide fittings matching and of same material as pipe units; comply with same standards, where applicable, except fittings need not be perforated where pipe is required to be perforated.
- G. Fittings and Specials for Underground PVC Pipe:
 - 1. Fittings and specials shall be PVC fittings conforming to the requirements of ASTM Standard F-1488.
- H. Domestic Hot & Cold Water Piping:
 - 1. Schedule 40 CPVC fittings for pressure 80 psi or less.
 - 2. Type "L" copper for pressure exceeding 80 psi.

2.03 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.
 - 1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
- B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.
 - 1. Tin-Lead Solder: ANSI/ASTM B 32, Grade 50A (50-50) for copper drainage piping.
 - 2. Silver Solder: ANSI/ASTM B 32, Grade 96.5TS for other piping.
- C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.
 - 1. Comply with Section IX, ASME Boiler and Pressure Vessel Code for brazing materials.
- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast iron flanges; raised-face for steel flanges, unless otherwise indicated. Gasket materials as recommended by manufacturer of particular fluid.
- E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.
- F. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering piping connectors which may be incorporated in the work include, but are not limited to, the following: Solder Safe 97/3, Dutch Boy 95/5, or approved equal.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leak-proof piping systems capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance.
1. Comply with ANSI B31 Code for Pressure Piping.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent enclosure elements of building; limit clearance to ½" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside insulation. Wherever possible, in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
- C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures.
- D. Piping System Joints: Provide joints of type indicated in each piping system.
1. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than three (3) threads exposed.
 2. Braze copper tube-and-fitting joints, 3" and larger, in accordance with ANSI B31.
 3. Solder copper tube-and-fitting joints, 2 ½" and smaller, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens. Use lead free solder.
 4. Weld pipe joints in accordance with ANSI B31.
 5. Weld pipe joints in accordance with recognized industry practice and as follows:
 - a. Weld pipe joints only when ambient temperature is above 0°F (-18°C) where possible.
 - b. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 - c. Install welding rings for butt-welded joints.
 - d. Use pipe clamps or tack-weld joints with 1" long weld; 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
 - e. Build up welds with stringer-bead pass, followed by hot pass, followed by cover of filler pass. Eliminate valleys at center and edges of each weld.

Weld by procedures which will ensure elimination of unsound or unfused metal,

- f. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
 - g. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.
 - h. At Installer's option, install forged branch-connection fittings wherever branch pipe of size smaller than main pipe is indicated; or install regular "T" fitting.
6. Weld pipe joints of steel water pipe in accordance with AWWA C206.
 7. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
 8. Lead Joint Installation: Tightly pack joint with joint packing material. Do not permit packing to enter bore of finished joint. Clean joint after packing. Fill remaining joint space with one pouring of lead to indicated minimum depth measured from face of bell. After lead has cooled, caulk joint tightly by use of hammer and caulking iron.
 9. Hubless Cast-Iron Joints: Comply with CISPI 310.
 10. Concrete Pipe Joints: Except as otherwise indicated, comply with applicable provisions of "Concrete Pipe Field Manual" by the American Concrete Pipe Association.
- E. Grooved Pipe Joints: Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions.
 - F. Acid Resistant Pipe Joints: Comply with pipe and fitting manufacturer's installation instructions for making joints, laying piping, protection. etc.
 - G. Install drainage piping (perforated) from lowest end of slope to highest, solidly bedded in filtering or drainage fill. Shape bed for bells of piping (if any). Place bells/hubs and grooved ends of units upstream. Lay perforated pipe with perforations down.
 - H. Paint all uninsulated piping underground with two coats of asphaltic paint. (Manual wiping is not acceptable.)
 - I. Wrap pipe that touches metal or is exposed to masonry with a layer of 6 mil polyethylene film or 15 lb. felt.
 - J. Spirally wrap all pipe lines embedded in concrete with two layers of 30 lb. felt.
 - K. Coat all exposed threads on galvanized steel pipe after assembly with two coats of zinc chromate. Remove pipe thread lubricants prior to applying paint.

3.02 CLEANING, FLUSHING, INSPECTING

- A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
 1. Inspect pressure piping in accordance with procedures of ANSI B31.

- B. Disinfect water mains and water service piping in accordance with AWWA C601.

3.03 PIPING TESTS

- A. Test pressure piping in accordance with ANSI B31.
- B. General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed. Remove control devices before testing. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
 - 1. Required test period is eight (8) hours.
 - 2. Test long runs of Schedule 40 pipe at 150 psi, except where fittings are a lower class or pressure rating.
 - 3. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
 - 4. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
- C. Repair piping systems sections which fail required piping test by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- D. Drain test water from piping systems after testing and repair work has been completed.

3.04 PIPING SERVICES FOR HVAC SYSTEMS

- A. Provide the following piping:
 - 1. Hot water boiler piping SCH 40 black steel.
 - 2. Condensate piping above grade SCH 40 PVC.
 - 3. Condensate piping below grade SCH 40 PVC.
 - 4. Chilled water piping to be schedule 40 black steel, butt welded 3" and over.

END OF SECTION

**SECTION 15065
ELECTRICAL COORDINATION**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. The requirements of Section 15000 Supplemental Provisions - Mechanical apply to this section.

1.02 DESCRIPTION OF WORK

- A. Provide and install all conduit and all control wiring including thermistor wiring for Division 15000 work.
- B. Provide and install all temperature control devices and equipment.
- C. Provide starters for all packaged equipment furnished under Division 15000 (final wiring under Division 16000).

1.03 RELATED WORK

- A. Electrical work required:
 - 1. All power wiring and conduit. (Provided and installed under Division 16000).
 - 2. Control wiring. (Provided and installed under Division 15000).
 - 3. Motor disconnects. (Provided and installed under Division 16000).
 - 4. Starters furnished and installed under Division 16000, except when furnished with packaged equipment; final wiring under Division 16000.

1.04 QUALITY ASSURANCE

- A. Requirements of the latest revision of the Standard Building Code and Standard Mechanical/Plumbing Code
- B. Wiring and conduit shall conform to the National Electrical Code, latest edition.
- C. Electrical equipment shall conform to NEMA standards and shall be UL listed.

1.05 SUBMITTALS

- A. Furnish to Electrical Contractor equipment shop drawings that indicate power connections.
- B. Prepare complete terminal-to-terminal wiring diagrams that show terminal designation on control items and equipment. Diagrams may be part of temperature control submittals.

PART 2 - PRODUCTS**2.01 MOTORS**

- A. Motors shall be furnished by the manufacturer or supplier of the specified equipment.
- B. General purpose motors shall be open drip-proof conforming to NEMA Design, Class B insulation, and continuous 40° C ambient, 60 Hz, 1.15 service factor, and 1800 RPM maximum speed unless specified otherwise. Voltage shall be as specified in individual Sections.
- C. Provide special motors where specified.
- D. Motors shall be single phase below 3/4 HP and three phase 3/4 HP and larger, unless specified otherwise.
 - 1. Single phase motors shall have built in overload protection.
 - 2. Single phase motors shall be capacitor start, capacitor run.
- E. All motors shall be NEMA Design E motors (per EPACT 1992).

2.02 EQUIPMENT POWER FACTOR

- A. Equipment requiring 1000 watts or more shall have a factor of 85% or greater at rated load conditions. Equipment with power factor less than 85% shall be corrected to at least 90% under full load operating conditions. Power factor corrective devices shall be switched with related equipment.

PART 3 - EXECUTION**3.01 CONTROL WIRING INSTALLATION**

- A. Control wiring shall be run in thin wall conduit
- B. Coordinate with other contractors.
- C. Check out system operation in all modes.

3.02 ADDITIONAL REQUIREMENTS

- A. Motor characteristics which change from that specified, due to the Contractor electing to use one of the optional manufacturers, or an updated model, etc., shall be coordinated with the Electrical Contractor.
- B. This Contract or is responsible for the cost and design of any revision necessary to provide proper control connections in full accordance with the National Electric Code and state and local codes.

END OF SECTION

**SECTION 15066
PIPING CONDENSATE DRAIN**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Provide condensate drain piping from cooling coil drain pans.

1.03 SHOP DRAWINGS

- A. Refer to Section entitled "General Provisions."

PART 2 - PRODUCTS**2.01 PIPE**

- A. Schedule 40 PVC.

2.02 FITTINGS

- A. Schedule 40 PVC

2.03 JOINTS

- A. Joints in PVC piping shall be made with solvent cement and primers ASTM F65C-80/D 2855-33.

2.04 MATERIAL

- A. All condensate piping inside mechanical room that is R/A plenum shall be insulated copper type "K", Mechanical and Plumbing contractors to coordinate.

PART 3 - EXECUTION**3.01 GENERAL**

- A. Piping shall be sloped uniformly toward drain, and provided with trap seal having a depth, in inches, equivalent to the total static pressure of the respective fan system. Traps shall be assembled using elbows and tees with threaded brass plugs to permit cleaning of trap and drain line. Piping shall be installed in a neat manner and shall be not smaller than full size of the equipment drain connection or three-quarters inch ($\frac{3}{4}$ ") whichever is larger.

3.02 JOINTS AND CONNECTIONS

- A. General: Joints and connections shall be made permanently air, gas, and watertight.

3.03 ROUTING

- A. Unless otherwise indicated, route pipe discharge as follows:
 - 1. Interior Equipment: Route to external condensate recovery system.

3.04 INSULATION

- A. Insulate if so specified in section describing insulation.

END OF SECTION

**SECTION 15080
PIPING SPECIALTIES**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division 15000 Basic Materials and Methods Section, and is a part of each Division-1 Specification section making reference to piping specialties specified herein.

1.02 DESCRIPTION OF WORK

- A. Extent of piping specialties required by this section is indicated on drawings and/or specified in other Division 15000 sections or as required to provide a complete system.
- B. Types of piping specialties specified in this section include the following:
 - 1. Pipe Escutcheons
 - 2. Pipeline Strainers
 - 3. Vandal-Proof Vent Caps
 - 4. Dielectric Unions
 - 5. Drip Pans
 - 6. Sleeves
 - 7. Sleeve Seals
- C. Piping Specialties furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 15000 sections.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of piping specialties of types and sizes required and whose products have been in satisfactory use in similar service for not less than 5 years.

1.04 SUBMITTALS

- A. Product Data: Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for pipeline strainers. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required pipeline strainer.
- B. Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of pipeline strainer. Include this data in Maintenance Manual.

PART 2 - PRODUCTS**2.01 MANUFACTURED PIPING SPECIALTIES**

- A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or, if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is Installer's option.
- B. Pipe Escutcheons:
1. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls or ceilings, and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
 2. Pipe Escutcheons for Moist and Wet Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate provide cast brass or sheet brass escutcheons, solid or split hinged.
 3. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.
- C. Low Pressure Y-Type Pipeline Strainers:
1. General: Comply with FCI 73-1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64" perforations at 233 per sq. in. Mechanical grooved type strainer may be used in grooved piping system.
 2. Threaded Ends, 2" and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
 3. Threaded Ends, 2½" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
 4. Flanged Ends, 2½" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
 5. Butt Welded Ends, 2½" and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.
 6. Available Manufacturers: Subject to compliance with requirements, manufacturers offering low pressure Y-type strainers which may be incorporated in the work include, but are not limited to, the following:
 - a. American Air Filter, an Allis-Chalmers Co.
 - b. Armstrong Machine Works.
 - c. Hoffman Specialty, ITT Fluid Handling Div.
 - d. Metraflex Co.
 - e. Sarco Co., Div. of White Consolidated.
 - f. Trane Co.
 - g. Trerice (H.O) Co.
 - h. Victaulic Co. of America
- D. High Pressure Y-Type Pipeline Strainers:
1. General: Comply with FCI 73-1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 250 psi

working pressure, with Type 304 stainless steel screens, with 3/64" perforations at 233 per sq. in. Mechanical grooved type strainer may be used in grooved piping systems.

2. Threaded Ends, 2" and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
3. Threaded Ends, 2½" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
4. Flanged Ends, 2½" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown pipe plug.
5. Butt Welded Ends, 2½" and Larger: Schedule 80 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.
6. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high pressure Y-type strainers which may be incorporated in the work include, but are not limited to, the following:
 - a. American Air Filter, an Allis-Chalmers Co.
 - b. Armstrong Machine Works
 - c. Hoffman Specialty, ITT Fluid Handling Div.
 - d. Metraflex Co.
 - e. Sarco Co., Div. of White Consolidated
 - f. Trane Co.
 - g. Trerice (H.O.) Co.
 - h. Victaulic Co. of America

E. Vandal-Proof Vent Caps:

1. General: Provide cast-iron vandal-proof vent caps, full size of vent pipe, caulked base connection for cast-iron pipes, threaded base for steel pipes.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering vandal-proof vent caps which may be incorporated in the work include, but are not limited to, the following:
 - a. Josam Manufacturing Co.
 - b. Smith (Jay R.) Manufacturing Co.
 - c. Wade Div., Tyler Pipe
 - d. Zurn Industries, Inc., Hydromechanics Div.

F. Dielectric Unions:

1. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering dielectric unions which may be incorporated in the work include, but are not limited to, the following:
 - a. Atlas Products Co.
 - b. Capital Mfg. Co., Div. of Harsco Corp.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. FMC Corp.
 - f. McNally, Inc.
 - g. PSI Industries
 - h. Stockham Valves and Fittings

2.02 FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2½". Reinforce top, either by structural angles or by rolling top over ¼" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.
- B. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - 1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" and smaller, 20 gauge; 4" to 6", 16 gauge; over 6", 14 gauge.
 - 2. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
 - 3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe, remove burrs.
- C. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one of the following:
 - 1. Lead and Oakum: Caulked between sleeve and pipe.
 - 2. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering mechanical sleeve seals which may be incorporated in the work include, but are not limited to, the following:
 - 1. Thunderline Corp. or approved equal

PART 3 - EXECUTION**3.01 INSTALLATION OF MANUFACTURED PIPING SPECIALTIES**

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Y-Type Strainers: Install Y-type strainers full size of pipeline in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blow down connection.
 - 1. Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment.
 - a. Pumps
 - b. Temperature control valves
 - c. Pressure reducing valves
 - d. Temperature or pressure regulating valves

- C. Vandal-Proof Vent Caps: Install vandal-proof vent caps on each vent pipe passing through roof, and elsewhere as indicated. Locate base of vent cap 6" above roof surface, or higher where required by Code.
- D. Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

3.02 INSTALLATION OF FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.
- B. Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves ¼" above level floor finish, and ¾" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.
 - 1. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings.
 - 2. Install iron-pipe sleeves at exterior penetrations, both above and below grade.
 - 3. Install steel-pipe sleeves except as otherwise indicated.
- C. Sleeve Seals: Install in accordance with the following:
 - 1. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

END OF SECTION

**SECTION 15100
VALVES****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. Bronze ball valve.
 - 2. Ductile-iron, single-flange butterfly valve.
 - 3. Ductile-iron, grooved-end butterfly valve.
 - 4. Bronze lift check valve.
 - 5. Bronze swing check valve.
 - 6. Bronze gate valve.
 - 7. Iron swing check valve.
 - 8. Iron, center-guided check valve.
 - 9. Iron gate valve
 - 10. Chainwheels.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. PTFE: Polytetrafluoroethylene plastic.
- H. SWP: Steam working pressure.
- I. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content less than or equal to 0.25% per Safe Drinking Water Act as amended January 4th 2011 Section1417.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

- B. ASME Compliance:
 - 1. ASME B16.10 for ferrous valve dimensions.
 - 2. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Lead Free silicon bronze (ASTM listed) valves shall be made with corrosion-resistant materials. Manufacturer shall provide third party certification tested in accordance with EN ISO 6509 regarding stress corrosion cracking and dezincification corrosion resistance.
- C. Bronze Valves: NPS 2 and smaller with threaded end or solder end, unless otherwise indicated.
- D. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- E. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller.

- 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for plug valves, for each size square plug-valve head.
- 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- H. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material that meets UL 2043 approved for inside air plenum, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO NIB-SEAL handle extension or approved equal.
 - 3. Butterfly Valves: Shall have 2" extended neck for insulation clearance.
- I. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
 - 5. Press: With press connections according to ASME B16.51
- J. Valve Bypass and Drain Connections: MSS SP-45.
- K. Manufacturers:
 - 1. Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Crane Co.; Crane Valve Group; Crane Valves.

2.2 PLASTIC VALVES

- A. CPVC Ball Valves
 - 1. Description:
 - a. Full port design.
 - b. Pressure rated to 100 PSI at 180°F nominal working pressure.

2.3 BRONZE BALL VALVES

- A. Two piece, full port, silicon bronze ball valves with the capability of accepting extended operating handles.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Model T/S/PC-585-80-LF (-NS) or T/S/PC-585-66-LF (-NS) or approved equal.
 - 2. Description:
 - a. Standard: MSS SP-110 and ASME A1124.14
 - b. CWP Rating: 600 psig.

- c. Body Design: Two piece bronze with threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing.
 - d. Body Material: Silicon bronze
 - e. Ends: Threaded or soldered.
 - f. Seats: Reinforced PTFE or TFE.
 - g. Stem: Stainless steel, silicon bronze
 - h. Ball: Stainless steel, silicon bronze
 - i. Port: Full.
- B. Three-Piece, full port, silicon bronze ball valves with the capability of accepting extended operating handles:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Model S/T-595-Y-LF (-NS) or S/T-595-Y-66-LF (-NS) or approved equal.
 - 2. Description:
 - a. Standard: MSS SP-110 and ASME A112.14.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece bronze with threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing.
 - d. Body Material: Silicon bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel, silicon bronze
 - h. Ball: Stainless steel (vented), silicon bronze
 - i. Port: Full.

2.4 DUCTILE IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - 1. Basis-of-Design Product: NIBCO Model LD-2000N-3/5 or approved equal.
Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 12 and Smaller CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Lead Free Aluminum bronze.

2.5 DUCTILE IRON, GROOVED-END BUTTERFLY VALVES

- A. 300 CWP, Iron, Grooved-End Butterfly Valves with EPDM Disc:
 - 1. Basis-of-Design Product: NIBCO Model GD-4765N-3/5.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 10 and Smaller CWP Rating: 300 psig.
 - c. NPS 12 CWP Rating: 200 psig.
 - d. Body Material: Polyamide Coated, ductile iron ASTM A395.
 - e. Stem: Two-piece stainless steel.
 - f. Disc: EPDM-Encapsulated, ductile iron.
 - g. Seal: EPDM.

2.6 BRONZE LIFT CHECK VALVES

- A. 200 CWP, Lift Check Valves with Nonmetallic TFE Disc:
 - 1. Basis-of-Design Product: NIBCO Model S-480-Y-LF or T-480-Y-LF.
 - 2. Description:
 - a. Standard: MSS SP-139
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical or horizontal flow
 - d. Body Material: Silicon bronze
 - e. Ends: Threaded or Soldered.
 - f. Disc: TFE.

2.7 BRONZE SWING CHECK VALVES

- A. 300 CWP, Bronze Swing Check Valves with TFE Disc:
 - 1. Basis-of-Design Product: NIBCO Model S-413-Y-LF or T-413-Y-LF or approved equal.
 - 2. Description:
 - a. Standard: MSS SP-139
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal or vertical (flow in upward direction) flow.
 - d. Body Material: Silicon bronze
 - e. Ends: Threaded or Soldered.
 - f. Disc: PTFE or TFE.

2.8 BRONZE GATE VALVES

- A. 300 CWP, NRS Bronze Gate Valves:
 - 1. Basis-of-Design Product: NIBCO Model S-113-LF or T-113-LF or approved equal.
 - 2. Description:
 - a. Standard: MSS SP-139.
 - b. CWP Rating: 300 psig.
 - c. Body Material: Silicon bronze
 - d. Ends: Threaded or Solder.
 - e. Stem: Lead free copper-Silicon Bronze, ASTM B99 Alloy C65100.
 - f. Disc: Solid wedge; lead free bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron.

2.9 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats:
 - 1. Basis-of-Design Product: NIBCO Model F918-LF or approved equal.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126 Class B, gray iron
 - e. Ends: Flanged.
 - f. Trim: Stainless steel or Silicon bronze.
 - g. Gasket: Asbestos free.

2.10 IRON, CENTER-GUIDED CHECK VALVES (PUMP DISCHARGE)

- A. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - 1. Basis-of-Design Product: NIBCO Model W/F-910-B-LF or approved equal.
 - 2. Description
 - a. Standard: Lead Free, MSS SP-125, FCI 74-1 and MIL-V-18436F.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126 Class B gray iron
 - d. Trim: Silicon bronze
 - e. Style: Globe or wafer, spring loaded.
 - f. Ends: Flanged or wafer.
 - g. Seat: Bronze.

2.11 IRON GATE VALVES

- A. Class 125, OS&Y, Cast Iron Gate Valves:
 - 1. Basis-of-Design Product: NIBCO Model F617-O-LF or F617RW
 - 2. Description:
 - a. Standard: Lead Free, MSS SP-70, Type I
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126 Class B, gray iron or ASTM A536 ductile iron. Ends: Flanged.
 - d. Trim: Stainless steel or Silicon bronze.
 - e. Disc: Solid wedge or resilient wedge
 - f. Packing and Gasket: Asbestos free.

2.12 BALANCING VALVES

- A. Hot Water Recirculation Balancing Valves:
 - 1. Lead-free brass body and pressure taps.
 - 2. Carbon/glass filled PTFE or virgin PTFE seats.
 - 3. Watts Series LFCSM-61-S or equal.

2.13 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements.
 - 1. Basis-of-Design Product: NIBCO Babbitt Sprocket Rims or a comparable product.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to ball and gate valve stems.
 - 3. Sprocket Rim with Chain Guides: Cast iron, aluminum, or bronze, of type and size required for valve
 - 4. Chain: Galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for ball and gate valves NPS 4 and larger and more than 96 inches above floor or more than three feet above ceiling. Extend chains to 60 inches above finished floor or just above ceiling.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.
- G. When soldering use paste flux that are approved by the manufacture for use with Lead Free Alloy.
- H. Install with union downstream of valve.
- I. Install with sweat adapters upstream of valve.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.

3. Throttling Service: Globe or ball valves.
4. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: spring-loaded lift valves with disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: center-guided seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

- A. Pipe NPS 2 and Smaller:
 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
 3. Equipment-Isolation Ball Valves: Safety-exhaust, bronze.
 4. Bronze Lift Check Valves: Class 125, disc.
 5. Bronze Swing Check Valves: Class 150, bronze disc.
- B. Pipe NPS 2-1/2 and Larger:
 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Ductile Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, ductile iron disc.
 3. Ductile Iron, Grooved-End Butterfly Valves: 300 CWP.
 4. Iron, Grooved-End Swing Check Valves: 300 CWP.
 5. Iron, Center-Guided Check Valves: Class 125, globe, resilient seat.
 6. Iron, Plate-Type Check Valves: Class 150 dual plate; resilient seat.

3.6 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

- A. Pipe NPS 2 and Smaller:
 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
 3. Bronze Lift Check Valves: Class 125, nonmetallic disc.
 4. Bronze Swing Check Valves: Class 150, nonmetallic disc.

- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Ductile Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, ductile iron disc.
 - 3. Ductile Iron, Grooved-End Butterfly Valves: 300 CWP.
 - 4. Iron, Grooved-End Swing Check Valves: 300 CWP.
 - 5. Iron, Center-Guided Check Valves: Class 125, globe, resilient seat.
 - 6. Iron, Plate-Type Check Valves: Class 125; dual plate; resilient seat.

3.7 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 3 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
 - 3. Bronze Swing Check Valves: Class 125, nonmetallic TFE disc.
 - 4. Bronze Lift Check Valves: Class 125, nonmetallic TFE disc.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 and Larger: May be provided with threaded ends instead of flanged ends.
 - 2. Ductile-Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
 - 3. Iron Swing Check Valves: Class 125 metal seats.
 - 4. Iron, Center-Guided Check Valves: Class 125, globe, resilient seat. (for pump discharge)

END OF SECTION

**SECTION 15160
EXPANSION COMPENSATION**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Extent of expansion compensation products required by this section is indicated on drawings and/or specified in other Division - 15000 sections.
- B. Types of expansion compensation products specified in this section include the following:
 - 1. Expansion Offsets in Piping
 - 2. Pipe Alignment Guides
 - 3. Pipe Anchor Points
- C. Expansion compensation products furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division-15 sections.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of expansion compensation products of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Comply with standards of the Expansion Joint Manufacturer's Association (EJMA).

1.04 SUBMITTALS

- A. Product Data: Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of expansion compensation product. Submit schedule showing manufacturer's figure number, size, location and features for each required expansion compensation product.
- B. Shop Drawings: Submit shop drawings for fabricated expansion loops, indicating location, dimensions, pipe sizes, location and method of attachment of anchors.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of expansion compensation product. Include this data in Maintenance Manual.

PART 2 – PRODUCTS**2.01 EXPANSION LOOPS**

- A. General: For piping systems fabricated from pipe and couplings, use one of the following methods for expansion compensation.
 - 1. Combination Couplings and Nipples: Provide expansion joints constructed of short pipe nipples and couplings, designed by manufacturer to suit intended

service. Provide removable ties to hold joint compressed or expanded during piping fabrication. Select couplings and gasket materials to match balance of piping system.

- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering expansion joints for grooved piping which may be incorporated in the work include, but are not limited to, the following:
1. Spears EJ-2-0406 for PVC and CPVC
 2. Victaulic Co. of America
 3. Or approved equal

PART 3 - EXECUTION

3.01 EXPANSION LOOPS

- A. General: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by Installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by Installer to properly anchor piping in relationship to expansion loops. See drawings for detail of anchors.
- B. Install expansion loops where indicated and elsewhere as determined by Installer for adequate expansion of installed piping system. Install in accordance with manufacturer's instructions. Provide pipe anchors alignment guides as indicated, and in accordance with manufacturer's recommendations. Align units properly to avoid end loading and torsional stress.

3.02 EXPANSION JOINTS

- A. General: Install expansion joints where indicated, and elsewhere as determined by Installer for adequate expansion of installed piping system. Install in accordance with manufacturer's instructions. Provide pipe anchors and pipe alignment guides as indicated, and in accordance with manufacturer's recommendations. Align units properly to avoid end loading and torsional stress.

END OF SECTION

**SECTION 15180
INSULATION**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Insulation included (but not limited to) is as follows:
1. Above grade chilled water piping.
 2. Below grade chilled water piping.
 3. Heat exchanger and other warm surfaces with an operating temperature of over 120°F and less than 400°F.
 4. Condensate piping from air conditioning units.
 5. Air conditioning supply and return ductwork.

1.03 SUBMITTALS

- A. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders," "substitutions" and other similar provisions.
- B. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS

2.01 INSULATION

- A. Materials listed in subsequent paragraphs of this specification are those used as basis of design; alternate manufacturer's equivalent products as listed herein will be accepted. The insulation contractor shall verify materials comply with requirements of NFPA 90, with regard to a flame spread rating of 25 or less; and a smoke developed/fuel contributed value of less than 50.
- B. Insulation and accessory materials to be as manufactured by the listed manufacturers or approved equal.
1. Calcium Silicate: Owens Corning "Kaylo," Pittsburgh Corning or Manville "Thermo-12."
 2. Fiberglass: Owens Corning, Knauf, CertainTeed, or Manville.
 3. Foamed Plastic Insulation: Armstrong "Armaflex," US Rubber "Ensoflex," Gustin Bacon "Ultra-Foam," Owens Corning "O-C" Halstead Industrial Products, or approved equal.
 4. Cellular Glass: Fed. Spec. HH-I-551a.
 5. Extruded polyethylene insulation: Nomaco Inc. "Therma-cell," Sentinel Energy Savings Products Div. of Packaging Energy Groups, Inc., "Senflex" or approved equal.
 6. Insulating Finish Cement: JM No. 301, BH Improved Super Powerhouse Cement, The Ruberoid Co, No. 412, or approved equal.
 7. Mastics, Sealers and Adhesives:

TYPE	Benjamin Foster	Insulcoustic	Childers	Johns Manville
Cellular glass bedding mastic		40 – 10	CP-70	375
General Purpose mastic	30 – 45	Vi AC	CP-10	
Vapor barrier sealant (indoor)	35 – 00	IC-501	CP-30	
Adhesive	30 – 35	IC-531	CP-89	
Fire Retardant sealer (outdoor)	60 - 35			
Foamed Plastic/Adhesive				57
Extruded Polyethylene	Non-Flammable by Insulation Manufacturer			

- C. Pipe Jacketing and Valve Covers (Ultra Violet Resistant:) Zestion PVC, CEEL-Tite, or approved equal.
- D. Metal Jacketing and Fitting Cover: Aluminum 0.016 gauge (minimum) smooth or corrugated, Childers Products Co., General Aluminum Supply Co. (Gasco,) Alcorjac by Insulcoustic Co., or approved equal.
- E. Molded Fiberglass Fitting Insulation: Molded Acoustical Products, Inc., West Easton, PA, 18042 or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Surfaces shall be clean and dry before attempting to apply insulation. A professional insulator with adequate experience and ability shall install insulation.
- B. Insulation is not to be installed until the piping and duct systems have been checked and found free of all leaks.
- C. Provide hanger or pipe support shields of 16 gauge (minimum) galvanized steel over or embedded in the insulation. Shield shall extend halfway up the pipe insulation cover and at least 6" on each side of the hanger. Securely fasten shield with pipe straps at each end. Insulate anchors adequately to prevent moisture condensation problems.
- D. Insulate piping installed in exposed locations such as machine rooms, equipment rooms, air handling unit rooms, all exterior above grade areas, kitchens, power houses, utility buildings, energy building or similarly identified locations where the insulation would be subject to physical damage shall be covered with metal jacketing. Elbows may be covered with fire rated and ozone resistant (for exterior locations) PVC covers in lieu of metal jacket.

3.02 ABOVE GROUND HEATING HOT WATER

- A. Material: Shall be insulated with 1½" thickness fiberglass insulation with all purpose jacket and self-sealing, pressure sensitive closure. Prior to installing the pipe insulation the pressure release paper shall be removed from the jacket laps. The pipe insulation shall be secured in place by applying pressure to the pressure sensitive closure system.
Elbows shall be installed with Zeston PVC fitting covers. All valves, flanges and other irregular fittings shall be insulated with pipe insulation segments and finished with a skim coat of air drying Johns Manville 375 cement and white glass fabric dipped in Foster's 30-36 coating or equal. Heating hot water copper runouts to fan coil units shall be insulated with ¾" thickness foam plastic insulation. All joints shall be sealed with adhesive.

3.03 WARM OR HOT SURFACES

- A. Insulate interior warm or hot surfaces with an operating temperatures of over 120°F and less than 400°F. These surfaces include, but not limited to, hot water storage heater and hot water expansion tank.
- B. Insulate with 1½" thick calcium silicate blocks, securely wired on and covered with poultry wire. Apply a finish coat of ½" insulating finish cement over the poultry wire. Trowel the exterior smooth.
- C. Insulate hot surfaces operating at over 400°F temperature with ¾" vee rib spacing lath and 1½" molded 85 per cent magnesia or calcium silicate blocks wired on over the spacing lath. Apply poultry wire over the magnesia blocks and give a ½" coat of insulating finish cement. Trowel the exterior smooth.

3.04 INTERIOR BOILER BREECHING AND STACK

- A. Interior Boiler Breeching and Stack: Shall be insulated with 2" thickness calcium silicate block insulation. The block insulation shall be applied over an air space provided by installing " vee ribbed lath. The insulation shall be wired in place with 16 gauge stainless steel tie wires and all joints shall be filled with Johns Manville 375 insulation cement. The insulation shall then be finished with a ½" layer of JM 375 hydraulic setting insulation cement reinforced with 1" hexagonal wire mesh.

3.05 PIPING

- A. Emergency Generator Muffler and Exhaust Piping: Shall be insulated with four (4) 1" layers of Grade "E" fiberglass insulation, per approved for temperature of 1200°F.
 - 1. The first layer shall be cut to wrap around the pipe and have "hog ring" staples applied on 12" centers along the longitudinal joint for temporary securement. The second layer shall be cut to wrap around the preceding layer and applied with all joints staggered and pulled up tight. "Hog ring" staples shall be applied on 8" centers along the longitudinal and butt joints. Piping below 12" diameter shall be secured as per single layer securement. Piping over 12" diameter shall be secured using stainless steel bands (0.5" x .015") at each butt joint and on 12" centers of intermediate bands.
 - 2. Insulation finishing cement: Prior to the application of the insulating finish cement, a layer of stainless steel 1" hexagonal mesh shall be applied to wrap around the Temp-Mat insulation with a 3" overlap at all edges and permanently wired using wire of the same material. All cut ends shall be turned in so as not to protrude through the finish. The insulation finish cement shall be mixed, applied and painted according to the manufacturer's recommendations.

3.06 CHILLED WATER PIPING

- A. Chilled water piping above grade shall be insulated with 2" thick fiberglass with all-purpose jacket.
- B. Chilled water piping in equipment room shall have a PVC jacket.
- C. Chilled water piping below grade shall be insulated with 2" thick foam glass, spiral wrapped with fiberglass cloth, and coated with two coats of plastic.

3.07 AIR CONDITIONING SUPPLY AND RETURN DUCTWORK

- A. Material: Shall be insulated with 2" thick ¾# density Johns Manville Micro-lite flexible glass fiber blanket insulation having a reinforced foil-scrim-kraft facing conforming to NFPA 90A.
- B. Application: The insulation shall be applied over 4" wide brushed strips of Foster's 85-20 adhesive spaced approximately 12" on center. The insulations shall be overlapped approximately 12" on center. The insulations shall be overlapped approximately 2" and stapled in place. All joints or breaks in the vapor barrier facing shall be sealed with a fire retardant coating equal to Foster's GPM 3500 reinforced with a layer of 4" wide white open weave glass fabric. All ducts 14" or larger in width shall have the insulation additionally secured with mechanical fasteners spaced approximately 12" on center maximum.

3.08 EXPOSED SUPPLY, RETURN AND OUTSIDE AIR DUCTS IN MECHANICAL EQUIPMENT SPACES

- A. Material: Shall be insulated with 2" thick 3# density Johns Manville 814 Spin-glas board insulation having a foil-scrim-kraft facing.
- B. Application: The board insulation shall be impaled over stick clips and washers spaced approximately 12" on center. All joints and breaks in the vapor barrier facing shall be sealed with 4" wide FSK tape to match the facing of the duct insulation.

3.09 INTERNAL DUCTWORK INSULATION

- A. Internal, thermal and acoustical ductwork insulation shall not be used.
- B. Internal insulation thickness shall be as follows:
 - 1. Supply duct, 1.5"
 - 2. Return duct, ½"
 - 3. Exposed duct
 - a. Supply duct, 2"
 - b. Return duct, 1"
 - c. Exhaust duct for energy recovery, 1"
- C. Flexible joints at fan outlets of single zone AC units, ductwork stack heads, multizone unit zone damper sections and duct connections to air handling units shall be insulated externally under Section 3.07 of these specifications.
- D. Stack heads for grilles and ceiling outlets may be internally or externally insulated by the sheet metal subcontractor. If insulated externally, insulation shall comply with requirements of Section 3.07 of these specifications.
- E. Apply insulation so that various elements provide maximum mutual support. On horizontal runs, install top and bottom first and wedge sides between top and bottom. Adhere insulation to duct with 100 percent coverage of Benjamin Foster 85-20, 3M - EC-35, Childers' CP-89, or approved equal adhesive. Install additional supports for insulation on top and sides of ducts on 12 inch centers. These supports may be "Grip Nails," "Stic-Klips" or 1½ inch diameter 20 gauge galvanized metal caps secured with #10 - ½ inch galvanized sheet metal screws.

- F. Apply a brush coat of fire retardant coating over all joints, visible cut edges and leading edges to prevent fiber erosion. If duct velocity exceeds 1500 fpm, apply a 4 inch wide glass tape over the coating, on joints, etc. and then apply a second coat of coating to seal the tape in place. Coatings which meet requirement of Mil. Spec. A-331C-G1 products are acceptable.
- G. Insulate condensate drain piping with 1" thick Type "FR" Armaflex.

3.10 DOMESTIC HOT WATER

- A. Domestic hot water mains shall be insulated with 1" thick fiberglass.

3.11 COMMERCIAL KITCHEN EXHAUST DUCT

- A. Duct insulation shall be ASTM E 2336 system, 1.5" thick, Thermal Resistance R-Value = 7.2
- B. Flame spread less than 25 and smoke developed rating less than 50.
- C. UL listed, Comply with NFPA 96, Uniform mechanical and building codes, latest edition, International Mechanical code.
- D. 2 Hrs fire rating.
- E. Comply with ASTM C 518, ASTM D 6329-03 (Resistant to Mold Growth).
- F. Manufacturer: Equal to UNIFRAX; FyreWrap.

END OF SECTION

SECTION 15210
VIBRATION ISOLATION

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Products of Mason Industries, Inc. are used in this Specification as a basis of type and quality. Approved manufacturers: Kinetics Noise Control, Vibration Eliminator Co., Amber/Bootin Co., Vibration Mounting & Control.
- B. All vibration isolation devices shall be the product of a single manufacturer. The vibration isolation manufacturer's representative shall provide technical supervision throughout the construction project, and shall provide the mechanical contractor a letter certifying that he has inspected all isolator installations and that all isolation devices have been provided, installed and properly adjusted in accordance with the manufacturer's instructions and with the approved submittals.

1.03 SUBMITTALS

- A. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders," "substitutions" and other similar provisions.
- B. Submittal is required for all vibration isolation materials. Submittals shall show type, dimensions, rated capacity, rated deflections, spring constants and identity color coding and labeling details and location diagrams.
- C. Air handling units with factory-installed spring isolators are acceptable, provided such isolators meet all requirements of this Specification, including submittal requirements for vibration isolators, and the requirement for technical supervision and certification letter.

PART 2 - PRODUCTS**2.01 DESCRIPTION OF ISOLATORS**

- A. Unless otherwise noted all mechanical equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflection. Deflections shall be as noted on the schedule or otherwise specified herein. All ferrous metal parts on vibration isolators for suspended or outdoor equipment shall be hot dipped galvanized.

2.02 SPECIFICATION A

- A. Double deflection neoprene mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered to avoid corrosion and have friction pads both top and bottom so they need not be bolted to the floor. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang. Mountings shall be type ND or rails type DNR as manufactured by Mason Industries, Inc.

2.03 SPECIFICATION B

- A. Spring type isolators shall be free standing and laterally stable without any housing and complete with ¼" neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height. Mountings shall be type SLF as manufactured by Mason Industries, Inc.

2.04 SPECIFICATION C

- A. Flexible metallic hose shall be annular close pitched braided bronze connection with copper tube ends for freon sweat end service. Hoses shall be installed parallel to the shaft refrigeration machine connection at right angles to the motion in expansion applications. Hoses shall be type BBF as manufactured by Mason Industries, Inc.

2.05 SPECIFICATION D

- A. Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include a scale drawing of the hanger showing the 30° capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc.

2.06 SPECIFICATION E

- A. Vibration hangers shall be as described in Specification D, but they shall be precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a scale drawing of the hanger showing the 30° capability. Hangers shall be type PC3ON as manufactured by Mason Industries, Inc.

2.07 SPECIFICATION F

- A. Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion.

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

Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be provided with an eye bolt on the spring end and provision to attach the housing to the flat iron duct straps. Submittals shall include a scale drawing of the hanger showing the 30° capability. Hangers shall be type W30 as manufactured by Mason Industries, Inc.

2.08 SPECIFICATION G

- A. Flexible neoprene connectors shall be used on all equipment as indicated on the drawings or on the equipment schedule. They shall be manufactured of multiple plies of nylon tire cord fabric and neoprene both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement. Straight connectors shall have two spheres. Connectors up to and including 1½" diameter may have threaded ends. Connectors 2" and larger shall be manufactured with floating galvanized flanges recessed to lock the connector's raised face neoprene flanges. Hoses shall be installed on the equipment side of the shut-off valves.
- B. Connectors shall be rated a minimum of 150 psi at 220°F. Flanged equipment shall be directly connected to neoprene elbows in the size range 2½ through 12" if the piping makes a 90° turn at the equipment. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer to prevent additional elongation under pressure. 12" and larger sizes operating above 100 psi shall employ control cables with end fittings isolated by means of ½" thick bridge bearing neoprene washer bushings designed for a maximum of 1000 psi.
- C. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies.
- D. Elbows shall be Mason-Flex type MFNEC, straight connectors Mason-Flex type MFTFU or MFTNC and control cable assemblies type ACC, all as manufactured by Mason Industries, Inc.

2.09 SPECIFICATION H

- A. Isolator pads shall be neoprene in compression waffle pad type, having a steel load plate bonded to a double ribbed neoprene pad. Pads shall be Mason Type "WSW" or approved equal.

2.10 SPECIFICATION I

- A. Flexible duct connectors shall be installed at the intake and discharge of all fans to reduce vibration transmission to air duct.
- B. On fans in AHU with over 2" static pressure, thrust restraints (Type 5) shall be installed per manufacturer's instructions.

PART 3 - EXECUTION**3.01 INSTALLATION OR APPLICATION**

- A. Specification G connectors shall be provided at pipe connections to air handling units and chillers/ice harvestors.
- B. All ductwork within Mezzanine Mechanical Rooms shall be supported with Specification D hangers, 1" spring deflection.

3.02 EQUIPMENT ISOLATION SCHEDULE

EQUIPMENT ITEM	SPECIFICATION	MINIMUM STATIC DEFLECTION
All Suspended Indoor HVAC Units	E, I	1.5"
All Floor Mounted HVAC Units	B	1.5"
Base Mounted Pumps	B	1.5"
In-Line Fans	E	1.5"
In-Line Pumps	E	1.5"
AHU Fans	A, I	1.5"

END OF SECTION

**SECTION 15400
PLUMBING**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Perform plumbing work for the following specific systems including, but not necessarily limited to:
 - 1. Plumbing fixtures and trim
 - 2. Sanitary and vent piping
 - 3. Domestic cold water system
 - 4. Domestic hot water system
 - 5. LP Gas System with Storage Tank

PART 2 - PRODUCTS

2.01 PLUMBING FIXTURES AND FITTINGS

- A. Quality: All plumbing fixtures shall be "First Quality" as defined and set forth in Commercial Standard CS 77-28 and/or NBS Simplified Practice Recommendation R10641 as promulgated by the US Department of Commerce. All enameled iron fixtures are to have acid-resisting white enamel.
- B. Fixtures and fittings proposed shall be from one manufacturer and of similar character in any room or location. Escutcheons, handles, etc., on the different fixtures shall be of the same design. All fixtures and fittings proposed shall be submitted for approval with cuts and full description. All exposed metal not otherwise specified shall be polished chromium on brass or bronze. All cold water supply to fixtures shall be provided with stops. Provide cast brass P-trap with cleanout for each lavatory and sink except as specifically noted.

2.02 FLOOR DRAINS

- A. The strainer size shall be as recommended by the manufacturer unless otherwise indicated on the drawings. The strainers shall be nickel alloy or polished brass. Provide tapped boss and trap primer floor drains as indicated on the drawings.

2.03 CLEAN-UP

- A. Fixtures shall be properly protected from damage during construction and shall be cleaned in accordance with manufacturer's instruction under this section of the specification.
- B. Clean all exposed metal surfaces from grease, dirt, paint or other foreign material. Fixtures, chrome plated piping, fittings and trim shall be polished before requesting acceptance of the system.

2.04 STERILIZATION OF PIPING

- A. All domestic water piping shall be sterilized in accordance with the procedure outlined in the 2004 Florida Building Code, Plumbing Section 610.

2.05 PIPING

- A. All soil, waste and vent piping above grade shall be of Schedule 40 PVC Type DWV unless otherwise specified. All waste lines below interior floor slab shall be Schedule 40 PVC. Wherever waste and vent piping occur in air plenum areas the waste and vent piping shall be service weight, no-hub, cast iron with stainless bands and neoprene gaskets.
- B. Soil piping outside the building to sanitary collection system shall be Schedule 40 PVC. Provide Schedule 80 PVC, SDR 16 or less, or heavy weight cast iron pipe under roadways.
- C. Domestic Cold Water Piping (not buried) shall be Type "L" hard drawn copper. Fittings shall be wrought. Joints shall be made with lead free solder and non-acid solder flux.
- D. Domestic Hot Water Supply and Recirculating Piping shall be Type "L" copper hard drawn. Fittings shall be wrought copper. Joints shall be made with lead-free solder. Piping shall be insulated.
- E. Buried water piping shall be Type "K" copper.
- F. Domestic hot and cold water piping shall be CPVC for pressures not exceeding 80 psi

2.06 CLEANOUTS

- A. Size: Cleanouts shall be of the same nominal size as the pipes to which they are connected up to four inches (4") in diameter and not less than four inches (4") for larger pipes.
- B. Spacing: Cleanouts shall be provided at not more than fifty feet (50') apart horizontal drainage lines of four inches (4") nominal diameter, and at not more than seventy-five feet (75') apart for larger diameter pipe.
- C. At change in direction: Cleanouts shall be provided at each change of direction of the building drain when the angle of change is 90°.
- D. At base of stacks: Cleanouts shall be provided at or near the base of each vertical stack.
- E. Direction of Cleanout: All cleanouts shall be installed so the cleanout opens in the direction of the flow of the drainage line, or provide a bi-directional element in the line.
- F. Access: Concealed cleanouts in walls shall be provided with a removable access cover.
- G. Covers: Where access cleanout boxes or covers are installed in the floor, the top surface shall be scoriated and the cover secured, but removable when necessary. Polished nickel-bronze. Install carpet type markers in carpeted areas.

2.07 VALVES**A. Gate Valves:**

1. Where required: Each item of equipment furnished, installed or serviced under this Division of the specifications to which piping is connected shall have ball valves provided at each piping connection.
2. Gate Valves: Up to 2½": Bronze, 125 lb. S.W.P., non-shock, screwed bonnet, non-rising stem, solid wedge, meeting Federal Specification WW-Y-54 C, Class A, Type 1.
3. Gated Valves 3" and Larger: Iron body, 125 lb S.W.P., non-shock, bolted bonnet, non-rising stem, solid wedge, meeting Federal Specification WW-V-58A, Class 1, Type 1, Flanged ends.

B. Ball Valves:

1. Valves 2" and smaller shall have threaded or soldered ends, port area equal to or greater than connecting pipe diameter, Class 150, two piece bronze body, brass ball, bronze stem, teflon seat and seals. Basis for design:

THREADED	SOLDER
Hammond 8201 (867)	Hammond 8211 (868)

2. Ball valves 3" and larger shall have threaded ends, port area equal to or greater than connecting pipe diameter, Class 150, three-piece bronze body, cast bronze ball, bronze stem, Teflon seat, blow-out proof stem and adjustable packing. Basis of design: Hammond 8504 (B13.)

C. Check Valves:

1. Copper Type: 125 lb S.W.P., bronze disc. screwed bonnet, meeting Federal Specifications WW-V-51d, Class A, Type IV.

D. Check Valves for Iron Pipe: Iron body with bronze trip, bolted cap. 125 lb., S.W.P., screwed fitting up to 2½", 3" and larger, flange fitted.**2.08 ESCUTCHEONS****A. Location:**

1. Chrome-plated: Provide where exposed piping passes through finished surfaces. Escutcheons for extended sleeves shall be of the type designed for that purpose.

2.09 SUPPORTING DEVICES**A. Material:** Pipe hangers for copper pipe shall be copper plated and for steel pipe shall be zinc plated.**B. Type:**

1. Horizontal cast iron piping not on grade shall be supported at not over 5' intervals with hangers. Hangers for cast iron soil and waste piping shall be split ring types with rods.

Hangers for water piping shall be clevis type or approved equal. Pipe hangers shall be capable of vertical adjustment after erection of the piping.

2. The size of the hanger shall be suitable for the pipe size, plus the insulation and a 16 gauge half-circle galvanized sheet metal 12" long insulation saddle. For non-insulated pipes, the size of the hanger shall be suitable for the pipe size.
- C. Inserts: Where it is desirable or necessary to support the pipe hangers to concrete, inserts shall be placed in the forms by the Mechanical Contractor prior to the time that concrete is poured.
- D. Tamp-Ins: Lead tamp-ins may be used when installed in a concrete or masonry wall or other like vertical surface to support a vertical hanger. Lead tamp-ins will not be permitted to support hangers to the underside of a concrete slab.
- E. Trapeze hangers: For parallel runs of above ground suspended piping, an acceptable trapeze-type hanger may be used. Provide permanent, non-conductive type wrapping between copper pipe and steel trapeze hangers.
- F. Sleeves:
 1. Location: Pipes passing through walls, floors shall have sleeves of the same materials as the pipe. Sleeves shall allow insulated pipes to pass without changing the insulation thickness. Clearance around sleeves shall be packed with glass fiber after completion of pipe work. Sleeves in all floor slabs except slabs on grade shall have pipe sleeves extended 1 inch above finish floor to prevent water from running through sleeves to area below. Make watertight, caulk with sealant around each sleeve.

2.10 SPECIALTY ITEMS

- A. Shock Absorbers - Water Hammer:
 1. Where required:
 - a. Install at each fixture or battery of fixtures.
 - b. Factory fabricated type with elastomeric bellows meeting the requirements of Plumbing Institute Standard P.D.I. WH201.
 - c. All water hammer arrestors are type "A" unless noted otherwise.
 2. Acceptable Manufacturers
 - a. Zurn
 - b. Wade
 - c. Josam
 - d. J.R. Smith
- B. Access Doors and Panels
 1. Where required: At all locations where concealed equipment, fixtures, valves, or devices must be made accessible for service, inspection or removal.
 2. Removable Ceiling Tile: At locations where piping specialties and other items of equipment will be located above acoustical tile ceiling, the work required under this Division shall include advising the Ceiling Installer before installation of the ceiling as to which tiles must be made moveable access doors.
The tiles designated as access doors shall be marked under this section of the specifications with a split shank slip in one corner of the tile, and tiles shall be installed so as to be easily removable.
 3. Other locations: For equipment furnished under this Division not having suitable means of access, properly sized steel access doors shall be provided by this Mechanical Contractor and installed by General Contractor as directed by this

Mechanical Contractor. Notify General Contractor of location and requirements. Fire ratings of access doors shall equal the surfaces in which they are installed.

4. Coordination of Locations: It shall be the responsibility of the Contractor installing the work covered by Division 15 to locate the access doors and panels and to guarantee the proper location of each access.
- C. Unions:
1. Where required: Each item of equipment furnished or installed under this Division of the specifications to which piping is connected.
- D. Flashing:
1. Sanitary Plumbing: Flash all pipes passing through roof, at roof line with neoprene boots. Coordinate with manufacturer of roof exact requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The contractor shall furnish all labor, materials, including gaseous equipment and instruments required to conduct tests of piping systems. Tests shall be as herein called for.
- B. Tests shall be conducted and the inspection of the piping shall be made in the presence of the Architect and/or Engineers.
- C. All sanitary piping shall be tested with a hydrostatic head of not less than 10 feet of water column for a period of 24 hours.
- D. All pressure piping shall be tested with a hydrostatic pressure of 150 pounds per square inch for a period of 4 hours.
- E. Material and/or joints found defective shall be replaced and/or corrected and additional tests shall be conducted after corrosion of work.

3.02 PIPE SIZING, DRAWINGS AND SPECIFICATIONS

- A. It is intended that work covered by these specifications and drawings include everything requisite and necessary to make the various systems complete and operative, irrespective of whether or not every item is specifically provided for. Any omission of direct reference herein to any essential item shall not excuse contractor from complying with the above intent, and state and local codes.
- B. Figured dimensions supersede scaled ones. Contractor shall take no advantage of and shall promptly call the Owner's Representative's attention to any error, omission or inconsistency in specifications and drawings.
- C. Special attention is directed to requirements that equipment and materials stated in specifications and/or indicated on drawings shall be furnished, except if otherwise noted, completely installed, adjusted and left in safe and satisfactory operating condition. Accessories, appliances and connections necessary for operation of equipment shall be provided to satisfaction of the Owner's Representative.

- D. Materials, apparatus or equipment specified or otherwise provided for on drawings, addenda, or change orders issued subsequent to award of contract shall be same brand, type, quality and character originally specified unless otherwise provided.
- E. Layout of equipment, accessories, specialties and suspended, concealed or exposed piping systems are diagrammatic unless dimensioned. In preparing show drawings, contractor shall check project conditions before installing work. If there are any interferences or conflicts, they shall be called to attention of the Owner's Representative immediately for clarification.
- F. The drawings indicate required size and points of termination of pipes and ducts and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of this contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further obstruction or cost to the Owner.
- G. Shop drawings shall be furnished by this contractor, indicating all changes to meet space requirements, code requirements and as necessary to resolve all space conflicts.
- H. It is intended that all apparatus be located symmetrical with architectural elements, and shall be installed at exact height and locations as shown on the architectural drawings. Refer to architectural details in completing and correlating work.
- I. The contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under the contract, prior to submitting his bid. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible.
- J. The contractor shall carefully examine any existing conditions, existing piping and ducts and premises and compare the drawing with the existing conditions, prior to submitting his bid.
- K. It cannot be too strongly emphasized that, except for work specifically excluded herein, every system shall be turned over to Owner installed completed, with components, ready for normal operation.
- L. Pipe sizes shall be at minimum allowed by local codes or as shown on the drawings, whichever is larger.
- M. If any pipe sizes on plans or specifications appear to be incorrect, Engineer should immediately be notified in writing by the plumbing contractor.

3.03 FINAL CLEANING

- A. Refer to "General Conditions" for requirements.

END OF SECTION

SECTION 15401
SANITARY SEWER AND SANITARY VENT PIPING

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. The work pertaining to this Division occurs within the confines of the building line, and within a boundary outside of the building line for a distance of five (5) feet, measured normal to the building line, or as indicated on the drawings.

1.03 SUBMITTALS

- A. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders," "substitutions" and other similar provisions.
- B. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. The following schedule covers materials unless otherwise specified under a particular System Section.

2.02 PIPE

- A. Cast iron soil pipe service or heavy centrifugally cast, ANSI A112.5.1, 2" through 15" size, bell and spigot joint (on all fire and smoke/fire rated walls and partitions).
- B. Hubless Cast-Iron Soil Pipe: CISPI 301; include coupling assembly. Gaskets shall conform to ASTM C 564
- C. PVC –DWV pipe and fittings, Schedule 40, ASTM D 2665-87, by Charlotte Pipe and Foundry everywhere except rated walls and partitions.

2.03 FITTINGS

- A. PVC Type DWV: ASTM D 2665-87 (listed), NSF Seal of Approval.

2.04 PIPE JOINTS

- A. Bell and spigot type joint shall be made with push-on compression type, neoprene gasket conforming to ASTM A-74-87 or lead and oakum (for under roadways).
- B. No hub type joints shall be "CLAMP-ALL" couplings constructed of 24 gauge type guides, Type 304 stainless steel, slotted housing (3" and 4" widths) with gasket guides, Type 304 stainless steel screw clamp, and matching neoprene (ASTM C-564) gasket that shall interlock with housing or "HUSKY 4000" couplings constructed of Type 304

stainless steel with stainless steel bolts to assemble the coupling, and matching neoprene (ASTM C-564) gasket that shall interlock with housing (for under roadways).

- C. Joints in copper piping shall be made with tin-antimony solder (lead free), silver solder, and non-acid flux.
- D. Joints in threaded piping shall be made with teflon tape or non-hardening pipe compound (Seal-tite.)
- E. Joints in PVC piping shall be made with solvent cement and primers conforming to ASTM F656-80/D 2855-83.
- F. Vent Flashing: Furnish 4 lb. lead flashing, material as recommended by roofing system manufacturer, or copper pitch pans for all vents through the roof. Type of flashing used shall be compatible with piping material.
- G. Pipe support brackets within piping chases and between wall studs shall be (at the contractor's option) Holdrite system components (Hubbard Enterprises) or Sumner Pipe Support & Alignment system ABS (polystyrene) material.
- H. Below grade piping identification and warning tape shall be 0.004 inch thick polyethylene, printed with a continuous two line message. Tapes used for non-magnetic piping materials shall have a metallic core. Acceptable manufacturer is Seton Name Plate Corporation or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. The design drawings are generally diagrammatic. They do not show every bend, off-set, elbow or other fitting which may be required in the piping for installation in the space allotted. Careful coordination of the work is necessary to avoid conflicts.
- B. PVC piping, fittings and other PVC materials shall not be installed in air conditioning plenums or equipment rooms used as air conditioning plenums.
- C. Joints and connections shall be made permanent and watertight.
- D. Run piping to sewer connection point 5'-0" outside of building or as indicated on drawings. Verify exact location and invert. Provide necessary interfacing fittings.
- E. Install 3" and larger horizontal soil and waste piping to 1/8" per foot minimum slope. Piping 2-1/2" and smaller shall be installed at a slope of 1/4" per foot minimum. Run horizontal vent lines to a minimum slope back to stacks and vertical vent lines as direct and free from bends as possible.
- F. For piping requiring insulation, lay out and carefully install piping with sufficient clearances to permit proper application of the insulation. If the piping is such that a neat insulation job cannot be obtained with reasonable effort the piping subcontractor shall relocate piping.
- G. Separate underground water piping and building sewer piping with undisturbed or compacted earth at least 10' horizontally if installed at the same level or lower than the sewer. Where water piping is closer than 10' to a sewer, place the bottom of the water

pipe at least 18" above the top of the sewer, or the sewer shall be encased in a concrete envelope.

- H. Minimum cover for exterior underground piping is 2 – 1/2 feet over pipe unless otherwise noted on plans. Carefully excavate trench to smooth finished surface; if cut is too deep, backfill with clean earth and hand tamp to compact bottom. Make depression at joints to receive bells, collars and couplings. Provide continuous support for pipe or conduit. Backfill shall be clean earth, free of rocks and debris completely enveloping pipe or conduit on both sides and top to a minimum thickness of 6". Carefully hand tamp backfill in 6" layers until 18" has been deposited over pipe.
- I. Place color coded 6" wide 0.004" thickness polyethylene printed plastic identification tape directly above all underground piping systems approximately 12" below finished grade. Tapes shall be continuously printed with "CAUTION" in large bold letters. Printed second line with type of service below. Red tape is to be used for sewer, (print type of service on tape; i.e., storm water.)

3.02 HANGERS AND SUPPORTS

- A. Vertical Piping shall be supported at its base and no greater than every story in height, not to exceed 15 foot intervals.
- B. Horizontal piping (suspended) shall be supported at each bend; at not more than five (5) foot intervals; except that pipe exceeding five (5) feet in length may be supported at not more than ten (10) foot intervals. Supports shall be adequate to maintain alignment and prevent sagging and shall be made directly behind the bell or coupling, where possible, not near the center of the pipe.
- C. Supports shall be connected to the building structure and not from other equipment, ducts or conduits.

3.03 LINE AND GRADE

- A. Install gravity lines at uniform grade to low point after field verification of low point invert.
- B. Run piping straight, plumb and grade in the direction indicated on the drawings.

3.04 JOINTING PIPE

- A. All pipe lines shall be correctly aligned before joints are made.
- B. Squarely cut pipe and properly ream to remove all constriction and burrs before making up the joints.
- C. Threaded Pipe: Ream all pipe after cutting and before threading. Use non-hardening pipe compound on male threads only at each joint and tighten joint to leave not more than three threads exposed.
- D. Copper Tube: Ream all pipe after cutting squarely, clean outside of tube ends and inside of fittings and tin end to be soldered. Apply non-acid solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

- E. Joints in hubless cast iron piping shall be made with mechanical couplings as specified herein.
- F. Joints in hubless cast iron horizontal (suspended) piping runs in excess of 4' -0" in length shall be made with mechanical couplings. Exception to this requirement shall be made to piping installed in battery fixture grouping chase spaces.
- G. Joining hubless cast iron soil pipe and fittings shall be in accordance with recommended practices described by the coupling manufacturer. "CLAMP-ALL" screw clamps shall be torqued to 100-125 inch pounds with a torque wrench. "HUSKY 4000" couplings shall be torqued to 80 inch pounds with a torque wrench.
- H. Provide nipples of same material and weight as pipe used. Provide extra strong nipples when length of unthreaded part of standard weight nipple is less than 1½".
- I. Provide reducing fittings (reducing bushings shall not be used) where changes in pipe sizes occur.
- J. Provide dielectric unions or flanges between copper and steel piping and between brassware and steel. Do not use steel and copper piping in the same system without such isolation.

3.05 PIPE PROTECTION

- A. Paint all uninsulated piping underground (except cast iron and PVC) with two coats of asphaltic paint (manual wiping is not acceptable.)
- B. Wrap soil pipe that touches metal or is exposed to masonry with a layer of 6 mil polyethylene film or 15 lb. roofing felt.
- C. Spirally wrap all pipe lines embedded in concrete with two layers of 30 lb. roofing felt.
- D. Coat all exposed threads on galvanized steel pipe with two coats of zinc chromate paint. Apply paint after assembling pipe.

3.06 TESTS

- A. A water test shall be applied to the sanitary and storm drainage systems either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test and each section shall be filled with water, but no section shall be tested with less than 10 feet head of water. In testing successive sections at least the upper 10 feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 feet of the system) shall have been submitted to a test of less than a 10 feet head of water. The water shall be kept in the system, or in the portion under test, for at least 90 minutes before inspection starts; the system shall then be tight at all points.
- B. An air test shall be made by attaching an air compressor or testing apparatus to any suitable opening and after closing all other inlets and outlets to the system, forcing air into the system until there is a uniform gauge pressure of 5 psi or sufficient to balance a column of mercury ten inches in height. This pressure shall be held without introduction of additional air for a period of at least [30] [60] minutes.
- C. Complete all field testing prior to insulation, wrapping and/or backfill.

3.07 PIPING

- A. Piping within the building and above the ground floor slab shall be service weight cast iron, copper, galvanized steel and PVC for underground applications.
- B. Underground piping shall be of PVC, CPVC, or polyethylene.
- C. Piping under roadways and paved parking lot shall be Schedule SDR 14. Hub and spigot type with neoprene rubber compression gaskets unless otherwise noted on the drawings.

3.08 VENT FLASHING

- A. Flash all pipes passing through roof, at roof-line with neoprene boots.
- B. Install flashing materials as required by roofing system manufacturer's details and methods.

END OF SECTION

**SECTION 15402
DOMESTIC COLD AND HOT WATER SUPPLY PIPING
AND HOT WATER CIRCULATING PUMPS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Provide all piping, valves, connectors and specialty items as indicated on plans and per accepted and approved industry standards to ensure a superior installation.
- B. Joints and connections shall be made permanent and watertight in accordance with accepted and approved industry standards.
- C. Bitumastic coated all direct buried copper pipe and fittings and where pipe contacts concrete or masonry penetrations.

1.03 SUBMITTALS

- A. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders," "substitutions" and other similar provisions.
- B. Submit manufacturer's data for review before any work is commenced.

PART 2 - PRODUCTS**2.01 GENERAL**

- A. Provide valves and specialties as specified under additional Sections of this Specification.

2.02 WATER HAMMER ARRESTORS

- A. Water hammer arrestors (shock stops) shall bear the P.D.I. seal of approval. Approved manufacturers are:
 - 1. Josam Manufacturing Company
 - 2. Zurn Industries, Inc.
 - 3. Wade, Inc.
 - 4. Jay R. Smith Manufacturing Company.

2.03 PIPE

- A. The following schedule covers materials unless otherwise specified under a particular System Section.
 - 1. Copper tube, Type L, hard drawn, ASTM B 88 (in all fire and smoke/fire rated walls and partitions).

**DOMESTIC COLD AND HOT WATER SUPPLY PIPING
AND HOT WATER CIRCULATING PUMPS
SECTION 15402 - 1**

2. Schedule 40 CPVC piping may be used for potable water service inside the building in lieu of Type L copper except in fire-rated partitions.
 3. Return air plenum ceiling, coordinate with HVAC contractor prior to construction.
- B. All underground piping shall be Schedule 40 CPVC piping may be used where in conformance with one or more of the following specifications: ASTM D-2946, ASTM F 441, and/or ASTM F 442. Depth of bury shall be a minimum of 2.5 feet except where value boxes or risers prohibit this.
- C. A pressure reducing valve must be installed to isolate the piping from the higher pressure risers.
- D. All piping in return air plenum shall be Type "L" copper or schedule CPVC (no PVC is allowed).

2.04 PUMPS

- A. Pumps to be lead free bronze body, bronze fitted with replaceable bronze casing wear rings, renewable bronze shaft seal and enclosed bronze impeller keyed to shaft and secured with locking screw, 125 PSI ANSI flanges where applicable, gauge tapping in casing with pump control for alternate operation.
- B. Pump design shall allow adequate space between pump and motor to permit servicing with a reasonable effort. Design for 175 PSI work pressure.
- C. Motors to be open drip proof with greaseable ball bearings with lifting lug.
- D. Acceptable Manufacturers: Weinman, B&G, Grundfos or approved equal.

2.05 FITTINGS

- A. Copper Tube: Wrought or cast, brass or copper, with solder joints.
- B. CPVC in conformance with one or more of the following specifications: ASTM D-2464, ASTM D-2466, and/or ASTM D-2467.

2.06 PIPE JOINTS

- A. Joints in copper piping shall be made with lead free solder and non-acid flux.
- B. Joints in threaded piping shall be made with Teflon tape or non-hardening pipe compound (Seal -tight).

PART 3 - EXECUTION

3.01 GENERAL

- A. The design drawings are generally diagrammatic. They do not show every bend, offset, elbow or other fitting which may be required in the piping for installation in the space allotted. Careful coordination of the work is necessary to avoid conflicts.

**DOMESTIC COLD AND HOT WATER SUPPLY PIPING
AND HOT WATER CIRCULATING PUMPS
SECTION 15402 - 2**

- B. Run all water lines parallel or perpendicular to building lines.
- C. For piping requiring insulation, lay out and carefully install piping with sufficient clearances to permit proper application of the insulation. If the piping is such that a neat insulation job cannot be obtained with reasonable effort, the piping subcontractor shall relocate piping.
- D. Separate underground water piping and building sanitary sewer with undisturbed or compacted earth at least 10' horizontally if installed at the same level or lower than the sewer. Where water piping is closer than 10' to a sewer, place the bottom of the water pipe at least 18" above the top of the sewer, or the sewer shall be encased in a concrete envelope as required.
- E. Minimum cover for exterior underground piping is two feet over insulation or pipe unless otherwise noted on plans. Carefully excavate trench to smooth finished surface; if cut is too deep, backfill with clean earth and hand tamp to compact bottom. Make depression at joints to receive flanges, collars, and couplings. Provide continuous support for pipe or conduit. Backfill to be clean earth, free of rocks and debris completely enveloping pipe or conduit on both sides and top to a minimum thickness of 6". Carefully hand tamp backfill in 6" layers until 24" has been deposited over pipe or conduit.
- E. Place color coded 6" wide 0.004" thickness polyethylene printed plastic identification tape directly above all underground piping systems approximately 12" below finished grade. Tapes shall be continuously printed with "CAUTION" in large bold letters and printed second line with type of service below (i.e. potable water).

3.02 TESTS

- A. Apply a water pressure test to all parts of the water supply system before the piping is concealed and before the fixtures and equipment are connected. Use a hydrostatic pressure of not less than 125 psig or 150% of system operating pressure, applied to the system for a period of four (4) hours. There shall be no leaks at any point in the system at this pressure.
- B. Leave concealed work uncovered until required tests have been completed, but if necessary, make tests on portions of the work and those portions of the work may be concealed after being inspected and approved.
Make repairs of defects that are discovered as a result of inspection or tests with new materials. Caulking, welding or other such sealing methods of screwed joints, cracks or holes will not be accepted. Repeat tests after defects have been eliminated.
- C. Complete all field testing prior to insulation, wrapping and/or backfill.

3.03 STERILIZATION

- A. As soon as the water piping has been thoroughly flushed out, sterilize the lines by introducing into them a solution of calcium hypochlorite or chloride of lime. Open and close all valves while system is being chlorinated. After the sterilizing agent has been applied for 24 hours, test for residual chlorine at the ends of the lines. If less than 10 parts per million is indicated, repeat the process. When tests show at least 10 parts per million of residual chlorine, flush out the system until all traces of the chemical used are removed. Make necessary connections to sterilized piping. **Sterilization shall be approved by the local Health Department.**

3.04 PIPE PROTECTION

- A. Paint all uninsulated piping underground with two coats of asphaltic paint. (Manual wiping is not acceptable)
- B. Wrap pipe that touches metal or is exposed to masonry with a layer of 6 mil polyethylene film or 15 lb. felt.
- C. Spirally wrap all pipe lines embedded in concrete with two layers of 30 lb. felt.
- D. Coat all exposed threads on galvanized steel pipe after assembly with two coats of zinc chromate. Remove pipe thread lubricants prior to applying paint.

3.05 WATER HAMMER ARRESTORS

- A. Quantity, size and location to provide coverage per manufacturer's guidelines and recommendations.
- B. Provide selected manufacturer's sizing and location requirements with submittals.

3.06 INSTALLATION OF PUMPS

- A. Install pumps where indicated, in accordance with manufacture's published installation instructions, with recommended clearance provided for service and maintenance.

END OF SECTION

**SECTION 15410
PLUMBING FIXTURES**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, drawing pool, apply to this Section.

1.02 DESCRIPTION OF WORK

- A. This Section includes plumbing fixtures and related components.
- B. Related Sections include the following:

1.03 RELATED SECTIONS

- A. Related sections includes the following:
 - 1. Division 15 Section "Drinking Fountains and Water Coolers."
 - 2. Division 15 Section "Plumbing Specialties" for backflow preventers and specialty fixtures not in this Section.

1.04 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.05 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.06 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities about plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.
- E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- F. NSF Standard: Comply with NSF 61-01, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Hand Sinks: NSF 2 construction.
 - 3. Plastic Bathtubs: ANSI Z124.1.
 - 4. Plastic Lavatories: ANSI Z124.3.
 - 5. Plastic Laundry Trays: ANSI Z124.6.
 - 6. Plastic Mop-Service Basins: ANSI Z124.6.
 - 7. Plastic Shower Enclosures: ANSI Z124.2.
 - 8. Plastic Sinks: ANSI Z124.6.
 - 9. Plastic Whirlpool Bathtubs: ANSI Z124.1 and ASME A112.19.7M.
 - 10. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 - 11. Slip-Resistant Bathing Surfaces: ASTM F 462.
 - 12. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
 - 13. Vitreous-China Fixtures: ASME A112.19.2M.
 - 14. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 - 15. Water-Closet, Flushometer Tank Trim: ASSE 1037.
 - 16. Whirlpool Bathtub Fittings: ASME A112.19.8M.
- I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucet Hose: ASTM D 3901.
 - 5. Faucets: ASME A112.18.1M.
 - 6. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 7. Hose-Coupling Threads: ASME B1.20.7.
 - 8. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 9. NSF Materials: NSF 61.
 - 10. Pipe Threads: ASME B1.20.1.

11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 12. Supply and Drain Fittings: ASME A112.18.1M.
- J. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:
1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 3. Faucets: ASME A112.18.1M.
 4. Hand-Held Showers: ASSE 1014.
 5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 6. Hose-Coupling Threads: ASME B1.20.7.
 7. Manual-Control Antiscald Faucets: ASTM F 444.
 8. Pipe Threads: ASME B1.20.1.
 9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- K. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1M.
 3. Manual-Operation Flushometers: ASSE 1037.
 4. Plastic Tubular Fittings and Piping: ASTM F 409.
 5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
 6. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.
- L. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
 2. Floor Drains: ASME A112.21.1M.
 3. Grab Bars: ASTM F 446.
 4. Hose-Coupling Threads: ASME B1.20.7.
 5. Hot-Water Dispensers: ASSE 1023 and UL 499.
 6. Off-Floor Fixture Supports: ASME A112.6.1M.
 7. Pipe Threads: ASME B1.20.1.
 8. Plastic Shower Receptors: ANSI Z124.2.
 9. Plastic Toilet Seats: ANSI Z124.5.
 10. Supply and Drain Protective Shielding Guards: ICC A117.1.
 11. Whirlpool Bathtub Equipment: UL 1795.

1.07 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 3. Faucet, Laminar-Flow Fittings: Equal to 10 percent of amount of each type and size installed, but not less than 2 of each type and size.
 4. Faucet, Flow-Control Fittings: Equal to 10 percent of amount of each type and size installed.
 5. Supply, Flow-Control Fittings: Equal to 5 percent of amount of each type and size installed.
 6. Shower, Flow-Control Fittings: Equal to 5 percent of amount of each type and size installed.
 7. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but not less than 12 of each type.
 8. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
 9. Flushometer Tank, Repair Kits: Equal to 5 percent of amount of each type installed, but not less than 2 of each type.
 10. Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.
 11. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. For fixture descriptions in other Part 2 articles where the subparagraph titles "Available Manufacturers," and "Manufacturers" introduce a list of manufacturers and their products or manufacturers only, the following requirements apply for product selection:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified in other Part 2 articles.
 2. Products: Subject to compliance with requirements, provide one of the products specified in other Part 2 articles.
 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified in other Part 2 articles.
 4. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified in other Part 2 articles.

2.02 LAVATORY FAUCETS

- A. Lavatory Faucet: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.
1. Products: Moen.

2. Maximum Flow Rate: 1.5 gpm (5.7 L/min.), unless otherwise indicated.
3. Body Material: Metal.
4. Finish: Brushed Nickel.
5. Type: Two-handle mixing.
6. Centers: 4 inches (102 mm).
7. Mounting: Deck, exposed.
8. Handle(s): Lever
9. Inlet(s): tubing, with NPS 1/2 (DN 15) male adaptor, NPS 1/2 (DN 15) female shank.
10. Spout: Rigid.
11. Spout Outlet: Aerator.
12. Operation: Non-compression, manual.
13. Drain: Pop up.

2.03 BATHTUB FAUCETS

- A. Bathtub Faucet: Include hot- and cold-water indicators; tub spout; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.
1. Manufacturer: Moen
 2. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
 3. Body Material: Cast brass.
 4. Finish: Polished chrome plate.
 5. Type: Single-control mixing with integral or field-installed check stops on hot- and cold-water supplies.
 6. Mounting: Concealed.
 7. Handle[s]: Lever.
 8. Bathtub Spout: With diverter.
 9. Antiscald Device: Integral with mixing valve.
 10. Supply Connections: NPS 1/2 (DN 15), NPS 1/2 (DN 15), union.
 11. Shower Head Material: Metallic.
 12. Head Type: Ball joint and head integral with mounting flange.
 13. Spray Pattern: Adjustable.

2.04 SHOWER FAUCETS

- A. Shower Faucet: Include hot- and cold-water indicators; tub spout; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.
1. Manufacturers: Moen
 2. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
 3. Body Material: Cast brass.
 4. Finish: Polished chrome plate.
 5. Type: Single-handle thermostatic and pressure balance with integral or field-installed check stops on hot- and cold-water supplies.
 6. Mounting: Concealed.
 7. Handle[s]: Lever
 8. Protection Device for Hand-Held Shower: Required.

9. Antiscald Device: Integral with mixing valve.
10. Supply Connections: NPS 1/2 (DN 15), NPS 1/2 (DN 15), union.
11. Shower Head Material: Metallic with chrome-plated finish.
12. Head Type: Hand held, slide-bar mounted.
13. Spray Pattern: Fixed.

2.05 SINK FAUCETS

- A. Sink Faucet: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.
 1. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
 2. Body Material: Copper or brass underbody with brass cover plate.
 3. Finish: Polished chrome plate.
 4. Mixing Valve: Single control.
 5. Centers: 4 inches (102 mm).
 6. Mounting: Deck, exposed.
 7. Handle[s]: Lever.
 8. Inlet[s]: NPS 1/2 (DN 15) male shank.
 9. Spout: Swing, round tubular.
 10. Spout Outlet: Pullout spray with 68" braided hose.
 11. Operation: Non-compression, manual.
 12. Drain: Tail piece with chrome strainer and basket.
 13. Tempering Device: Thermostatic

2.06 TOILET SEATS

- A. Toilet Seat: Solid plastic.
 1. Manufacturers: Bemis or equal.
 2. Size: Elongated.
 3. Color: White.

2.07 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Guard: Manufactured, plastic covering for hot- and cold-water supplies and trap and drain piping and complying with ADA requirements.
 1. Manufacturers: Trubro or equal

2.08 WATER CLOSETS

- A. Water Closets: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for gravity-type tank operation.
 1. Products:
 - a. American Standard, Inc.
 - b. Briggs Industries, Inc.
 - c. Crane Plumbing/Fiat Products.
 - d. Gerber Plumbing Fixtures Corp.
 - e. Kohler Co.
 - f. Mansfield Plumbing Products, Inc.
 - g. Sterling Plumbing Group, Inc.

2. Style: Close coupled.
 - a. Bowl Type: Elongated, Round front with siphon-vortex, siphon-wash, design. Include bolt caps matching fixture.
 - b. Height: Accessible.
 - c. Design Consumption: 1.28 gal./flush (4.8L/flush).
 - d. Tank: Gravity type with trim. Include cover.
 - e. Trip Mechanism: Lever-handle.
 - f. Color: White.
 3. Supply: NPS 1/2 (DN 15) chrome-plated brass or copper with loose-key stop.
 4. Toilet Seat: Closed cover with slow close hinge
- B. Water Closets: Accessible, floor-mounting, vitreous-china fixture designed for gravity-type tank operation.
1. Products:
 - a. American Standard, Inc.
 - b. Briggs Industries, Inc.
 - c. Crane Plumbing/Fiat Products.
 - d. Kohler Co.
 2. Style: Close coupled.
 - a. Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
 - b. Height: Accessible.
 - c. Design Consumption: 1.28 gal./flush (4.8 L/flush).
 - d. Tank: Gravity type with trim. Include cover.
 - e. Trip Mechanism: Lever-handle.
 - f. Color: White.
 3. Supply: NPS 1/2 (DN 15) chrome-plated brass or copper with loose-key stop.
 4. Toilet Seat: Open front less cover

2.09 LAVATORIES

- A. Lavatories: Accessible, vitreous-china fixture.
1. Products:
 - a. Proflo.
 - b. Kohler Co.
 - c. American Standard, Inc.
 - d. Briggs Industries, Inc.
 - e. Crane Plumbing/Fiat Products.
 - f. Gerber Plumbing Fixtures Corp.
 - g. Mansfield Plumbing Products, Inc.
 - h. Peerless Pottery, Inc.; < Insert product name and model number >.
 - i. Sterling Plumbing Group, Inc.
 2. Type: Self rimming.
 3. Oval Lavatory Size: 19 by 16 inches (483 by 406 mm)
 4. Faucet Hole Punching: Three, 4-inch (102-mm) centers, hole[s].
 5. Faucet Hole Location: Top.
 6. Color: White.
 7. Faucet: Lavatory with pop-up waste.
 8. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.

9. Drain: See faucet.
10. Drain Piping: NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40) chrome-plated cast-brass trap; thick tubular brass waste to wall; and wall escutcheon.
11. Protective Shielding Guard

2.10 BATHTUBS

- A. Bathtubs, Enameled, cast iron.
 1. Products:
 - a. Kohler Co.
 - b. ProFlo
 - c. American Standard, Inc.
 - d. Bootz Plumbingware Co.
 - e. Briggs Industries, Inc.
 - f. Crane Plumbing/Fiat Products.
 - g. Mansfield Plumbing Products, Inc.
 2. Bathing Surface: Slip resistant.
 3. Size: 60 by 30 inches (1525 by 765 mm).
 4. Color: White.
 5. Drain Location: Left, Right end.
 6. Accessibility Options: ADA compliant.
 7. Faucet: Bathtub.
 8. Supplies: NPS 1/2 (DN 15) copper tubing with ball, gate, or globe valves.
 9. Drain: chrome-plated exposed parts; brass pop-up waste and overflow.
 10. Drain Piping: cast-brass trap and waste.

2.11 INDIVIDUAL SHOWERS

- A. Individual Showers: Accessible shower enclosure by others.

2.12 SINKS

- A. Sinks: counter-mounting, stainless-steel fixture.
 1. Products:
 - a. Dayton Products, Inc.
 - b. Elkay Manufacturing Co.
 - c. Franke, Inc., Kitchen Systems Div.
 - d. Just Manufacturing Co.
 - e. Kohler Co.
 - f. Moen, Inc.
 - g. Sterling Plumbing Group, Inc.
 - h. ProFlo.
 2. Overall Size: See schedule on drawing sheet P001.
 3. Number of Compartments: See schedule on drawing sheet P001.
 4. Sink Faucet: See schedule on drawing sheet P001.
 5. Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops.
 6. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated cast-brass trap, 0.045-inch- (1.1-mm-) thick tubular brass waste to wall, and wall escutcheons, tailpiece, strainer and basket.

2.13 MOP SINKS

- A. Service Basins: Flush-to-wall, floor-mounting basin with rim guard.
 - 1. Products:
 - a. Crane Plumbing/Fiat Products.
 - b. Florestone Products Co.
 - c. Precast Terrazzo Enterprises, Inc.
 - d. Stern-Williams Co., Inc.
 - 2. Shape: Rectangular.
 - 3. Size: [24 by 36 inches (610 by 915 mm).
 - 4. Rim Guard.
 - 5. Color: Not applicable.
 - 6. Faucet: See schedule on drawing sheet P001.
 - 7. Drain: Grid with NPS 3 (DN 80) outlet.
 - 8. Options: See schedule on drawing sheet P001.

PART 3 - EXECUTION**3.01 EXAMINATION**

- A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-hanging fixtures with tubular waste piping attached to supports.
- F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install counter-mounting fixtures in and attached to casework.

- H. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Refer to Division 15 Section "Valves" for general-duty valves.
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- N. Install toilet seats on water closets.
- O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- P. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- Q. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- R. Install shower, flow-control fittings with specified maximum flow rates in shower arms.
- S. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- T. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- U. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.
- V. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for escutcheons.
- W. Set fixtures in leveling bed of cement grout. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for grout.

- X. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.
- F. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.05 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets, shower valves, and to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.

3.06 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.

3.07 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

**SECTION 15421
FLOOR DRAINS AND SHOWER DRAINS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Provide trap primers for all floor drains in toilet rooms and at the locations shown on the drawings.

1.03 SUBMITTALS

- A. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions" and other similar provisions.

PART 2 – PRODUCTS**2.01 DRAINS**

- A. Drains shall be of the type and materials as scheduled on the drawings.
- B. Provide all necessary bolts, clamping rings and appurtenances to effect a complete installation.
- C. Acceptable Manufacturers: Zurn, Wade, Josam, J.R. Smith
- D. Floor drain shall be Zurn Z-415, Shower drain shall be Zurn FD2250; both with trap primer (Zurn or Equal).

2.02 SHOWER PANS

- A. Shower pans shall be constructed of polyethylene concealed chlorinated waterproofing membrane; nominal 0.040-inch thickness, equal to Chloraloy. All joints and/or seams shall be welded tight with CPE (non-plasticized chlorinated polyethylene) solvent bonding liquid or xylene.

PART 3 – EXECUTION**3.01 INSTALLATION**

- A. Drains
 - 1. Install all drains in accordance with the manufacturer's instructions.
- B. Shower Pans
 - 1. The floor of each individual shower, the shower area portion of combination shower and drying room, and the entire shower and drying room where the two are not separated by curbing or partition shall be made watertight with a shower pan fabricated in place.

2. The shower pan material shall be cut to size and shape of the area indicated, in one piece to the maximum extent practicable, allowing not less than eight inches for turn-up on walls or partitions, and shall be folded over the curb with an approximate return of one-fourth of curb height. The upstands shall be placed behind any wall or partition finish.
3. Shower pans shall be clamped to drain as specified herein.
4. After installation of the pan and the finished floor, the drain shall be temporarily plugged below the weep holes.
 - a. The floor area shall be flooded with water to a minimum depth of 4 inches at curb areas and 1 inch without curbs for a period of 24 hours.
 - b. Any drop in the water level during the test, except for evaporation, shall be reason for rejection, repair and retest.

END OF SECTION

**SECTION 15423
CLEANOUTS AND CLEANOUT ACCESS COVERS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Provide cleanouts and cleanout access covers at the locations shown on the drawings or specified herein.

.03 SUBMITTALS

- A. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders," "substitutions" and other similar provisions.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. Cleanouts and cleanout access covers shall be of the type and materials as scheduled on the drawings.
- B. Provide all necessary bolts, and appurtenances to effect a complete installation.

PART 3 - INSTALLATION**3.01 CLEANOUTS AND CLEANOUT ACCESS COVERS**

- A. Install all cleanouts and cleanout access covers in accordance with the manufacturer's instructions.
- B. Pipe cleanouts shall be full pipe size; however, maximum size required is 4".
- C. Exterior cleanouts below grade shall be extended to finish grade. Pour a concrete pad 18" in diameter x 6" thick or 18" square around cleanout; slope top down approximately 2" from cleanout to edge of pad so that edge of pad is flush with grade.

END OF SECTION

SECTION 15425
DOMESTIC WATER HEATERS - ELECTRIC

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section

1.02 DESCRIPTION OF WORK

- A. Furnish and install domestic water heaters as scheduled and at the locations shown on the drawings.
- B. Acceptable manufacturers are Rheem, A.O. Smith, Lochinvar, PVI Industries, State Industries, and Ruud.

1.03 SUBMITTALS

- A. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions" and other similar provisions.
- B. Submit manufacturer's data for review before any work is commenced.

PART 2 - MATERIALS**2.01 MATERIALS**

- A Water Heater
 - 1. Water heater shall be electric powered model of capacity shown on drawings. Tank shall have approved working pressure of 125 psi. The tank shall be of steel construction with vitreous glass lining and shall have two or more magnesium anodes to provide electrolytic protection. The entire water heater shall be U.L. listed and A.S.M.E. rated and shall meet or exceed ASHRAE 90.1 or 90.2, 2004 .
 - 2. Heater to be completely insulated and jacketed. The jacket shall be 16 gauge galvanized steel with baked enamel finish. Jacket shall have an access door.
 - 3. All tanks are to be lined with vitreous glass.
 - 4. Control compartment shall house 120 Volt control circuit transformer, transformer fusing, magnetic contactor(s), immersion style operating thermostats, high limit thermostat(s), element fusing per N.E. C. and commercial grade stainless steel sheathed flange mounted elements with pre-wired terminal leads.
 - 5. Provide ASME rated temperature and pressure relief valve, terminal block wiring, 180°F water temperature approval and UL Listing.
 - 6. Provide storage tank drain.

B Pan Drain

1. The pan drain shall extend full-size and drain pipe shall terminate over a suitably located floor drain or extend to the exterior of the building and terminate no less than six (6) inches or more than twenty-four (24) inches above grade.
2. The discharge from the relief valve shall be piped full-size separately to the outside of the building or to another approved terminal as provided for safety pan drain terminals but in no case shall the discharge from a relief valve be trapped. A visible air gap fitting shall be located in the same room as the water heater.
3. Provide magnesium storage tank savers.
4. All units shall have a 5 year limited warranty against tank failure.

C. Expansion Tank

1. All electric water heaters shall have expansion tank as per Plumbing code.

PART 3 - EXECUTION**3.01 INSTALLATION****A. Ball Valves**

1. Provide ball valves on both the incoming cold water and leaving hot water supply piping.
2. Cold water supply shall also be equipped with a vacuum relief valve downstream of the ball valve.
3. Provide unions to facilitate replacement of the storage tank and/or heater.
4. Heat trap shall be installed in the hot water supply piping unless the unit provided has integral heat traps.
5. Installation shall be per contract drawings and manufacturers installation instructions.

END OF SECTION

**SECTION 15450
PLUMBING FIXTURES AND TRIM**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of all plumbing fixtures and trim as specified herein.

1.03 SUBMITTALS

- A. All plumbing fixtures shall be "First Quality" as defined and set forth in Commercial Standard CS77-28 as promulgated by the US Department of Commerce. All fixtures are to be white vitreous china unless otherwise specifically noted. Where enameled iron fixtures are specified, they shall be furnished with acid resisting enamel.
- B. Fixtures and fittings proposed shall be from one manufacturer and of similar character in any room or location. Escutcheons, handles, etc., on the different fixtures shall be of the same design.
- C. The fixture numbers and types are scheduled on the drawings and are used to indicate type and quality of fixtures desired.
- D. All fixtures and fittings proposed shall be submitted for approval with cuts and full description.
- F. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders," "substitutions" and other similar provisions.

PART 2 - PRODUCTS**2.01 FIXTURE TRIM**

- A. Flush valves and water closet seats shall be as scheduled on the drawings.
- B. All exposed metal not otherwise specified shall be polished chromium on brass or bronze. All supply valves shall have renewable seats and discs. All hot and cold water supply to fixtures shall be provided with stops. Provide P-trap with cleanout for each lavatory and sink except as specifically noted.
- C. All seats shall be solid, white, open front seat with checking and self-sustaining, stainless steel hinge.
- D. Chair carriers and combination chair carriers and fittings shall be as scheduled on the drawings.

- E. Provide a concealed hanger type lavatory chair carrier with short foot mounted in the chase to support lavatories shown on walls of a chase.
- F. Provide through toggle bolts, 18" thickness steel backing plate, and wall hangers for support of lavatories on 6" or thicker concrete block walls.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Layout fixtures as indicated on the drawings.
- B. Carefully install fixtures in accordance with manufacturer's data with sufficient clearances to coordinate with accessories, specialties and equipment specified in other divisions of these specifications and/or as shown on the drawings.
- C. Hangers and carriers shall be installed in accordance with manufacturer's recommendations and in accordance with good practice and workmanship.
- D. Clean all exposed metal surfaces from grease, dirt, paint or other foreign material.
- E. Fixtures shall be properly protected from damage during construction and shall be cleaned in accordance with manufacturer's instruction under this section of the specification.
- F. Fixtures, chrome-plated piping, fittings and trim shall be polished before requesting acceptance of the system.

END OF SECTION

**SECTION 15465
INSULATION FOR PLUMBING SYSTEMS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Above grade domestic hot water supply and recirculating piping.
- B. Above grade waste lines and trap from ice machines and waste line receiving condensate from air conditioning units to a point of connection to a soil line receiving waste from 4 or more plumbing fixtures.
- C. Above grade domestic cold water piping in exterior walls, vented attic, vented ceiling spaces and vented soffits with ½" fiberglass and all service jacket.
- D. Above grade domestic hot water piping in exterior walls, vented attic, vented ceiling spaces and vented soffits with ¾" fiberglass and all service jacket.
- E. Above grade exterior domestic cold water piping.
- F. Handicap lavatory exposed water and waste piping.
- G. Above grade water piping exposed in unheated areas.

1.03 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.
- B. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders," "substitutions" and other similar provisions.

PART 2 - PRODUCTS**2.01 INSULATION/ACCESSORY MATERIALS**

- A. Materials listed in subsequent paragraphs of this specification are those used as basis of design; alternate manufacturer's equivalent products as listed herein will be accepted. The insulation contractor shall verify materials comply with requirements of NFPA 90, with regard to a flame spread rating of 25 or less and; a smoke developed/fuel contributed value of less than 50.
- B. Insulation and accessory materials to be as manufactured by the listed manufacturers or approved equal.
 - 1. Fiberglass: Owens Corning, Knauf, CertainTeed, or Manville.
 - 2. Foamed Plastic Insulation: Armstrong "Armaflex," US Rubber "Ensolex," Gustin Bacon "Ultra-Foam," Owens Corning "O-C" Halstead Industrial Products, or approved equal.

3. Cellular Glass: Fed. Spec. HH-I-551a.
4. Extruded polyethylene insulation: Nomaco Inc. "Therma-cell," Sentinel Energy Savings Products Div. of Packaging Energy Groups, Inc., "Senflex" or approved equal.
5. Insulating Finish Cement: JM No. 301, BH Improved Super Powerhouse Cement, The Ruberoid Co, No. 412, or approved equal.
6. Mastics, Sealers and Adhesives:

TYPE	BENJIMAN FOSTER	INSULCOUSTIC	CHILDERS	JOHNS MANVILLE
Cellular glass bedding mastic	30 – 45	40 – 10	CP-70	375
General purpose mastic	35 – 00	Vi AC	CP-10	
Vapor barrier Sealant (indoor)	30 – 35	IC-501	CP-30	
Adhesive	85 – 20	IC-531	CP-89	
Fire retardant sealer (outdoor)	60 – 35			
Foamed Plastic/Adhesive				57
Extruded Polyethylene	Therma-Cel 950 adhesive			

7. Pipe Jacketing and Valve Covers (Ultra Violet Resistant:) Zeston PVC, CEEL-Tite, or approved equal.
8. Metal Jacketing and Fitting Cover: Aluminum 0.016 gauge (minimum) smooth or corrugated, Childers Products Co., General Aluminum Supply Co. (Gasco,) Alcorjac by Insul-coustic Co., or approved equal.
9. Molded Fiberglass Fitting Insulation: Molded Acoustical Products, Inc., West Easton, PA, 18042 or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Insulation is not to be installed until the piping has been tested and found free of all leaks. Surfaces shall be clean and dry before attempting to apply insulation. A professional insulator with adequate experience and ability shall install insulation.
- B. Provide hanger and pipe support shields of 16 gauge (minimum) galvanized steel over or embedded in the insulation. Shield shall extend halfway up the pipe insulation cover and at least 6" on each side of the hanger. Securely fasten shield with pipe straps at each end. Insulate anchors adequately to prevent moisture condensation problems.
- C. Insulation installed in exposed locations such as machine rooms, equipment rooms, air handling rooms, all exterior above grade areas, kitchens, energy building or similarly identified locations where the insulation would be subject to physical damage shall be covered with metal jacketing. Elbows may be covered with fire rated and ozone resistant (for exterior locations) PVC covers in lieu of metal jacket.

3.02 WARM OR HOT SURFACES

- A. Insulate interior warm or hot surfaces with an operating temperatures of over 120°F and less than 400°F. These surfaces include, but not limited to, hot water storage heater and hot water expansion tank.
- B. Insulate with 1½" thick calcium silicate blocks, securely wired on and covered with poultry wire. Apply a finish coat of ½" insulating finish cement over the poultry wire. Trowel the exterior smooth.

3.03 CONDENSATE PIPING FROM ICE MACHINES

- A. Insulate condensate piping and waste lines from ice machines with foamed plastic insulation extruded polyethylene, ½ inch thickness.
- B. Miter cut insulation to fit the pipe fittings. Use approved cement to seal all joints, seams and ends in the insulation.

3.04 HORIZONTAL WASTE PIPING RECEIVING AIR CONDITIONING CONDENSATE

- A. Shall be insulated with 1" thickness AP-T fiberglass pipe insulation. Prior to installing the insulation the pressure release paper shall be removed from the jacket laps. The insulation shall be secured in place by applying pressure to the pressure sensitive closure system. All fittings shall be insulated with pipe insulation segments and finished with Foster's 30-35 barrier coating or equal, reinforced with white open weave glass fabric.

3.05 UNDERGROUND PIPING

- A. Insulate all underground domestic hot water piping with 1½" thickness cellular glass preformed split sectional pipe insulation. Miter cut insulation and carefully fit to the pipe fittings. All cellular glass to be shop bore-coated with Keene's cement prior to shipment to the job site. Apply cellular glass bedding mastic to all edges of the cellular glass insulation to fill any voids between joints in the insulation.
- B. Wire the cellular glass in place with stainless steel or copper wire 9" on centers. Expansion joints in the insulation with ¼" clearance shall be made 10' on centers. The expansion joints shall be filled with asphalt impregnated felt and covered with the jacket.
- C. Apply a heavy coat of vapor barrier sealant to outside of the cellular glass and embed a layer of open mesh glass fabric cloth into the mastic; carefully apply the cloth smoothly and overlap all transverse and longitudinal joints at least 2". Apply a second heavy and final coat of mastic over the cloth and finish to a reasonably smooth surface.
- D. All legs of underground expansion loops and expansion ells shall be additionally covered with 2" thickness fiberglass 7 pounds per cubic foot density fiberglass pipe insulation applied under the cellular glass and under the glass fabric jacket.

3.06 ABOVE GROUND DOMESTIC HOT WATER AND DOMESTIC HOT WATER RECIRCULATION PIPING

- A. Shall be insulated with ASJ fiberglass pipe insulation unless noted otherwise. Prior to installing the insulation the pressure release paper shall be removed from the jacket laps. The insulation shall be secured in place by applying pressure to the pressure sensitive closure system. All fittings shall be insulated with molded fiberglass pipe insulation segments and finished with Foster's 30-35 vapor barrier coating or equal, reinforced with a layer of white open weave glass fabric.

- B. Main pipe sizes 2" and smaller shall have 1" thickness insulation unless noted on drawings.
- C. Pipe sizes 2½" and larger shall have a 1½" thickness insulation.
- D. Branch runouts in walls or chases up to 2" shall have ½" thickness insulation.

3.07 HANDICAP LAVATORY EXPOSED HOT WATER AND WASTE PIPING

- A. Shall be insulated with a molded flexible vinyl insulation system as manufactured by Handi Lav-Guard model #102W or Skal + Gard model #WG-200B, or approved equal.

END OF SECTION

**SECTION 15499
EQUIPMENT FURNISHED UNDER OTHER DIVISIONS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Contractor shall make final utility connections to that equipment furnished by Owner. This equipment is listed and/or tabulated in another section of the specifications or on the drawings.
- B. This equipment shall include, but is not limited to, the following:
 - 1. Ice Maker
 - 2. Washing Machines/Dryers
 - 3. Unit Kitchens
 - 4. Refrigerators
 - 5. Dishwasher
 - 6. Equipment Furnished Sinks
 - 7. Requirements of other Divisions
 - 8. Kitchen Hood
- C. Take adequate precautions to insure that installed fittings are protected from damage during construction.

1.03 SUBMITTALS

- A. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders," "substitutions" and other similar provisions.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Install fixture, equipment and make connections as recommended by the manufacturer(s).
- B. Supports: Wall mounted fixture supports to be 1/8" thickness (minimum) steel plates with thru-bolts, unless otherwise indicated.
- C. All exposed metal piping not otherwise specified shall be polished chromium on brass or bronze unless noted otherwise on the drawings.
- D. All supply service valves shall have renewable discs and seats.

- E. All ½" and smaller cold and hot water supplies to fixtures and equipment shall be supplied with stops.
- F. All ¾" and larger connections to fixtures and equipment shall be supplied with ball valves.
- G. Provide gas shut off cocks to isolate gas fired equipment.
- H. Provide unions at all equipment connections.
- I. At completion of work clean all fixtures and exposed metal surfaces of grease, dirt, paint or other foreign material.
- J. Chrome plated piping, fittings, trim and equipment shall be polished before requesting acceptance of the system.

END OF SECTION

**SECTION 15651
REFRIGERATION PIPING SYSTEMS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-15 Basic Materials and Methods sections apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of refrigeration piping systems work is indicated on drawings and schedules, and by requirements of this section.
- B. Applications for refrigeration piping systems include the following:
 - 1. Refrigerant suction line piping between compressors and cooling coils.
 - 2. Refrigerant liquid line piping between liquid receivers and cooling coils.
 - 3. Refrigerant discharge line piping between compressors and condensers.
 - 4. Refrigerant condenser drain line piping between condensers and liquid receivers.
- C. Refer to appropriate Division-15 sections for insulation required in connection with refrigeration piping; not work of this section.
- D. All refrigerant piping to be installed per Manufacturer recommendations per specified length. Install with longer Run Kit if needed.

1.03 QUALITY ASSURANCE

- A. Requirements of the latest revision of the Florida Building Code and Florida Mechanical/Plumbing Code.
- B. Manufacturers: Firms regularly engaged in the manufacture of refrigeration piping products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- C. Installer: A firm with at least 3 years of successful installation experience on projects with refrigeration piping system work similar to that required for project.
- D. ANSI Code Compliance: Comply with applicable provisions of ANSI B31.5 and ANSI B31.5a, "Refrigeration Piping", and extend applicable lower pressure limits to pressures below 15 psig.
- E. Safety Code Compliance: Comply with applicable portions of ANSI/ASHRAE 15, "Safety Code for Mechanical Refrigeration".
- F. Brazing: Comply with applicable requirements of ANSI B31.5, and ANSI B31.5a, "Refrigeration Piping", pertaining to brazing of refrigeration piping for shop and project site locations.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data for refrigeration piping systems materials and products.
- B. Brazing Certification: Certify brazing procedures, brazers and operators in accordance with ASME standards (ANSI B31.5).
- C. Shop Drawings: Submit scaled layout drawings of installed refrigeration pipe and fittings including, but not necessarily limited to, pipe sizes, locations, elevations and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between piping and proximate equipment.

PART 2 - PRODUCTS**2.01 REFRIGERATION PIPING MATERIALS AND PRODUCTS**

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 Code for refrigeration piping where applicable, base pressure rating on refrigeration piping system maximum design pressures.
- B. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigeration piping systems. Where more than one type of material or product is indicated, selection is Installer's option.

2.02 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-15 Basic Materials and Methods section, "Mechanical Identification", in accordance with the following listing:
 - 1. Refrigeration Piping: Plastic pipe markers.

2.03 BASIC PIPE, TUBE AND FITTINGS

- A. General: Provide pipe, tube and fittings complying with Division-15 Basic Materials and Methods Section, "Pipe, Tube and Fittings", in accordance with the following listing:
 - 1. Tube Size 4-1/8" and Smaller: Copper tube.
 - a. Wall Thickness: Type ACR, hard drawn temper.
 - b. Fittings: Wrought-copper, solder-joints.
 - c. Joints: Soldered, silver-lead solder, ANSI/ASTM B 32, Grade 96 TS.
 - 2. Tube Size 3/4" and Smaller: Copper tube.
 - a. Wall Thickness: Type ACR, soft annealed temper.
 - b. Fittings: Cast copper-alloy for flared copper tubes.
 - c. Joints: Flared.
 - 3. Tube Size 7/8" through 4-1/8": Copper tube.
 - a. Wall Thickness: Type ACR, soft annealed temper.
 - b. Fittings: Wrought-copper, solder joints.
 - c. Joints: Soldered, silver-lead solder, ANSI/ASTM B 32, Grade 96 TS.

2.04 BASIC PIPING SPECIALTIES

- A. General: Provide piping specialties complying with Division-15 Basic Materials and Methods section, "Piping Specialties", in accordance with the following listing:
1. Pipe escutcheons
 2. Pipe sleeves

2.05 BASIC SUPPORTS, ANCHORS AND SEALS

- A. General: Provide supports, anchors and seals complying with Division-15 Basic Materials and Methods section, "Supports, Anchors and Seals", in accordance with the following listing:
1. Adjustable steel clevises, adjustable roller hangers, and adjustable pipe roll stands for horizontal piping hangers and supports.
 2. Two-bolt riser clamps for vertical piping supports.
 3. Concrete inserts, C-clamps and steel brackets for building attachments.
 4. Protection shields for insulated piping support in hangers.
 5. Copper flashing for piping penetrations.

2.06 SPECIAL REFRIGERATION VALVES

- A. General: Special valves required for refrigeration piping systems include the following types:
1. Globe and Check Valves:
 - a. Globe and Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300° F (149° C) temperature rating, 500 psi working pressure.
 - b. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless steel spring, 250° F (121° C) temperature rating, 500 psi working pressure.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering globe and check valves that may be incorporated in the work include the following:
1. Henry Valve Co.
 2. Parker Hannifin Corp., Refrigeration & Air
 3. Conditioning Div
 4. Sporlan Valve Co.
- C. Solenoid Valves:
1. Two-way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24 volt, 60 hertz, UL-listed, 1/2" conduit adapter, 250° F (121° C) temperature rating, 400 psi working pressure.
- D. Manual Operator: Provide manual operator to open valve.
- E. Available Manufacturers: Subject to compliance with requirements, manufacturers offering solenoid valves which may be incorporated in the work include the following:
1. Alco Controls Div., Emerson Electric Co.
 2. Automatic Switch Co.
 3. Sporlan Valve Co.
 4. See Division 1 for prior approval.

2.07 REFRIGERATION ACCESSORIES

- A. Refrigerant Strainers: Brass shell end and connections, brazed joints, monel screen, 100 mesh, UL-listed, 350 psi working pressure.
- B. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL-listed 200° F (93° C) temperature rating, 500 psi working pressure.
- C. Refrigerant Filter-Driers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron cover plate with steel cap screws, replaceable filter-drier core, 500 psi working pressure.
- D. Evaporator Pressure Regulators: Provide corrosion-resistant, spring-loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.
- E. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL-listed.
- F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering refrigeration accessories which may be incorporated in the work include the following:
 - 1. Alco Controls Div., Emerson Electric Co.
 - 2. Henry Valve Co.
 - 3. Parker-Hannifin Corp., Refrigeration & Air Conditioning Div.
 - 4. Sporlan Valve Co.
 - 5. See Division 1 for prior approval.

PART 3 - EXECUTION**3.01 INSTALLATION OF BASIC IDENTIFICATION**

- A. General: Install mechanical identification in accordance with Division-15 Basic Materials and Methods section, "Mechanical Identification".

3.02 INSTALLATION OF REFRIGERATION PIPING

- A. General: Install refrigeration piping in accordance with Division-15 Basic Materials and Methods section "Pipe, Tube, and Fittings", and in compliance with equipment manufacturer's recommendations.
- B. Pitch refrigerant piping in direction of oil return to compressor. Provide oil traps and double section risers where indicated, and where required to provide oil return.
- C. Insulate suction line with ½" Armaflex.
- D. Provide aluminum jacket for exposed lines.

3.03 INSTALLATION OF PIPING SPECIALTIES

- A. Install piping specialties in accordance with requirements of Division-15 Basic Materials and Methods section, "Piping Specialties".

3.04 INSTALLATION OF SUPPORTS, ANCHORS AND SEALS

- A. Install supports, anchors and seals in accordance with requirements of Division-15 Basic Materials and Methods section, "Supports, Anchors and Seals".

3.05 INSTALLATION OF SPECIAL REFRIGERATION VALVES

- A. General: Install refrigeration valves where indicated, and in accordance with manufacturer's instructions. Remove accessible internal parts before soldering or brazing, replace after joints are completed.
 - 1. Solenoid Valves: Install in refrigerant piping as indicated with stem pointing upwards.
 - a. Wiring of solenoid valves is specified in applicable Division-15000 Sections, and is included as work of this section.

3.06 INSTALLATION OF REFRIGERATION ACCESSORIES

- A. Refrigerant Strainers: Install in refrigerant lines as indicated, and in accessible location for service.
- B. Moisture-Liquid Indicators: Install as indicated on refrigerant liquid lines, in accessible location.
- C. Refrigerant Filter-Dryers: Install in refrigerant lines as indicated, and in accessible location for service.
- D. Evaporator Pressure Regulators: Install in refrigerant suction lines or evaporator outlets as indicated. Adjust, if required, for proper evaporator pressure.
- E. Refrigerant Discharge Line Mufflers: Install as indicated, in horizontal or downflow portion of hot-gas lines, immediately after leaving compressor; not in riser.

3.07 EQUIPMENT CONNECTIONS

- A. General: Connect refrigerant piping to mechanical equipment in manner shown, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.08 FIELD QUALITY CONTROL

- A. Refrigerant Piping Leak Test: Prior to initial operation, clean and test refrigerant piping in accordance with ANSI B31.5 and ANSI B31.5a, "Refrigeration Piping". Perform initial test with dry nitrogen, using soap solution to test all joints. Perform final test with 27" vacuum, and then 200 psi using electronic leak detector. System must be entirely leak-free.
- B. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

END OF SECTION

**SECTION 15673
AIR COOLED CONDENSING UNITS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of air cooled condensing units as specified herein

1.03 RELATED WORK

- A. Direct expansion air handling units.

1.04 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 15000
- B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
- C. Submit electrical requirements for power supply wiring. Include diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- D. Submit manufacturer's installation instructions under provisions of Section 15000.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 15000.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver product to site in factory-fabricated protected containers, with factory-installed shipping skids and lifting lugs.
- B. Store in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate unit for any purpose, temporary or permanent, until system has been cleaned and tested under observation.

1.08 WARRANTY

- A. The compressor shall have a limited warranty for five years. All other covered components shall have a limited warranty for one year.

PART 2 – PRODUCTS**2.01 APPROVED MANUFACTURERS**

- A. Carrier
- B. Lennox
- C. Trane
- D. York

2.02 GENERAL

- A. Furnish and install an air-cooled condensing unit. The unit shall be shipped completely factory assembled, piped and wired internally ready for field connections. In addition, manufacturer shall test operate unit at the factory before shipment.
- B. The condensing unit shall be a standard product of a firm regularly engaged in the manufacture of heating-cooling equipment.
- C. The manufacturer shall have parts and service available throughout the United States and Canada.

2.03 CONSTRUCTION

- A. All wiring shall be in compliance with NEC or CEC. Shall be rated in accordance with ARI Standard 210/240-94 or 365-87. All models shall have U.L. listing and be U.L.C. certified.
- B. Cabinet shall be constructed of galvanized steel, which has been through a metal wash preparation and have a pre-painted finish. Openings shall be provided for refrigerant lines and power connection entry.

2.04 FAN

- A. Fan shall be direct drive propeller type fan(s). Motor(s) shall have inherent protection devices and shall be protected from moisture.

2.05 COMPRESSOR

- A. Compressors shall be resiliently mounted, suction cooled, overload protected, and have internal excessive current and temperature protection. All compressors shall have crankcase heater

2.06 COILS

- A. Coil(s) shall be non-ferrous construction with aluminum-enhanced fins mechanically bonded to durable rifled copper tubes. Coil(s) shall be pressure leak tested.

2.07 REFRIGERANT SYSTEM

- A. Refrigerant system shall include fully serviceable liquid and suction line service valves, gauge ports, hi-capacity drier (field installed), thermometer well, high-pressure switch, low-pressure switch and timed-off control. Control options available shall include thermostat.

2.08 OPTIONS

- A. Furnish and factory apply phenolic epoxy coating to condenser coils and case section.
- B. Furnish and field install heavy-duty coil guard to protect coils

2.09 ELECTRICAL

- A. Furnish and factory install unit disconnect switch. Switch shall have spring loaded weatherproof cover.
- B. Furnish and factory install dual 115v ground fault circuit interrupter (GFCI) type. Shall have spring loaded weatherproof cover. Power wiring shall be field provided.

PART 3 — EXECUTION**3.01 INSTALLATION**

- A. Install according to manufacturer's requirements, shop drawings, and Contract Documents.
- B. Install air handler alignment on concrete foundations on vibration isolation as called for on drawings.
- C. Arrange the piping on each vessel to allow for dismantling the pipe to permit coil removal and cleaning.
- D. Arrange unit for filter exchange without interference.
- E. Coordinate electrical installation with electrical contractor.
- F. Coordinate controls with control contractor.
- G. Provide all material required to ensure a fully operational and functional air handler.
- H. Install all condensing units on minimum, tapered 4" high concrete housekeeping pad.

END OF SECTION

**SECTION 15715
SPLIT SYSTEM AIR CONDITIONER**

PART 1 GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes furnishing and installing air cooled condensing units and air handling units with a direct expansion evaporator section and an electric heating section.
 - 1. The work includes equipment, piping, insulation, controls, and related appurtenances for air conditioning and ventilation. Completion must result in a complete and operable system.

1.03 REFERENCES

- A. Air-Conditioning and Refrigeration Institute (ARI):
 - 1. ARI 210/240 Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 90A-2002 Installation of Air Conditioning and Ventilating Systems
- C. Underwriters Laboratories, Inc. (UL):
 - 1. UL-900 Test Performance of Air Filter Units

1.04 SUBMITTALS

- A. General: Submittals shall be according to Section 01300 - Submittals.
- B. Manufacturer's Literature: Submit 6 copies of the manufacturer's descriptive data for units to be used on this project.
- C. Operating and Maintenance Instructions: Submit 6 copies of the manufacturer's operating and maintenance instructions for the units to be used on this project.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A company regularly engaged in the manufacture of air cooled condensing units and air handling units, and who issues a complete catalog of data on such products.
- B. Testing Requirements: The units shall be tested for proper operation at the factory.
- C. Labeling Requirements: Units shall be Underwriter's Laboratories, Inc. (UL). listed and labeled.

PART 2: PRODUCTS**2.01 APPROVED MANUFACTURERS**

- A. Trane
- B. Carrier
- C. Lennox
- D. York

2.02 EQUIPMENT

- A. Condensing Unit:
 - 1. Condenser coil shall be of nonferrous construction. Coil shall have aluminum fins, mechanically bonded to seamless copper tubes. Coil shall be circuited for subcooling.
 - 2. Unit shall have direct driven propeller-type fans arranged for vertical discharge. Condenser fan motors shall have inherent protection, and shall be of the permanently lubricated type, resiliently mounted. Each fan shall have a safety guard. Controls shall be included for cycling fans for intermediate season operation.
 - 3. Controls shall be factory wired and located in a separate enclosure. Safety devices shall consist of high and low pressure switches and compressor overload devices. Unit wiring shall incorporate a positive acting timer to prevent short cycling of compressor if power is interrupted. Timer shall prevent compressor from restarting for approximately 5 minutes after shutoff. Units shall have a transformer for 24 volt control circuit.
 - 4. Casing shall make unit fully weatherproof for outdoor installation. Casing shall be of galvanized steel, zinc phosphatized, and finished with baked enamel or an equivalent finish approved by the Government. Openings shall be provided for power and refrigerant connections. Panels shall be removable to provide access for servicing.
 - 5. Only one liquid line, one suction line, and one power supply connection shall be required for each unit.
 - 6. Refrigerant System:
 - a. Condenser fan - Direct drive fan shall move large air volumes uniformly through entire condenser coil for high refrigerant cooling capacity. Vertical air discharge shall minimize operating sounds and eliminate damage to lawn and shrubs. Fan motor shall have sleeve bearings and be inherently protected. Motor shall be totally enclosed for maximum protection from weather, dust and corrosion. Provide rain shield on motor for additional protection from moisture. Furnish with louvered steel top fan guard. Fan service access to be accomplished by removal of top panel.
 - b. Provide PVC coated steel wire coil guard.
 - 7. Controls:
 - a. Timed-Off Control – Provide Timed-Off Control Kit to prevent compressor short-cycling and allow time for suction and discharge pressure to equalize. Shall permit compressor startup in an unloaded condition. Provide automatic reset with 5 minute delay between compressor shutoff and startup.

8. Compressor:
 - a. Provide Copeland Scroll™ Compressor for high efficiency with uniform suction flow, constant discharge flow and high volumetric efficiency and quiet operation.
 - b. Compressor motor shall be internally protected from excessive current and temperature.
 - c. Compressor shall be installed in the unit on resilient rubber mounts for vibration free operation.
 9. Cabinet:
 - a. Provide powder paint finish for superior rust and corrosion protection.
 - b. Provide sweat connection suction and liquid lines to be located on corner of unit cabinet.
- B. Air Handling Unit:
1. Cooling coils shall be of nonferrous construction with aluminum fins mechanically bonded to seamless copper tubes. All tube joints shall be brazed with phoscopper or silver alloy.
 2. Evaporator fan section shall have forward-curved blades, double-inlet fans. Fans shall be statically and dynamically balanced and supplied with permanently lubricated bearings.
 3. The casing shall be made of galvanized steel and finished with baked enamel or an equivalent finish approved by the Contracting Officer. Access panels shall be provided for maintenance of the equipment. A one-piece drain pan shall be provided under the complete coil section, with drain connections on both sides. One drain connection shall be connected to a floor drain as shown on the drawings. The other drain connection shall be sealed. The complete unit shall be insulated with thick fiberglass insulation.
 4. Refrigerant System:
 - a. Refrigerant Line Connections: Suction (vapor) and liquid lines shall have sweat connections that extended outside of the cabinet for ease of connection.
 - b. Provide check and expansion valve for use with R-410A systems, wide range valve with Chatleff style fitting, factory installed, internal to cabinet.
 5. Blower:
 - a. Provide variable speed motor (VSM) to maintain specified air volume throughout external static range. Motor shall be controlled by BDC3 electronic blower drive control that allows blower to operate at two of eight air volumes or speeds available. Speeds may be field selected on BDC3 control depending on blower coil unit size and air volume desired.
 6. Filter:
 - a. Provide tool-less access to filter area for quick and easy servicing. Disposable frame type filter shall be furnished and factory installed in rails in cabinet.
 7. Cabinet:
 - a. Cabinet shall be constructed of heavy gauge galvanized steel, completely insulated with thick fiberglass insulation.
 - b. Pre-painted steel cabinets shall have mildly textured enamel finish with primer coat on unpainted side of all panels.
 - c. Units shall ship in one piece but may be disassembled into two

- separate sections for ease of installation in tight applications.
 - d. Provide thick rubber gasket between sections of the two piece cabinets to provide an air tight seal.
 - e. No external screw heads on sides of cabinet for tight installations without damage to walls or woodwork.
 - f. Provide removable panels provide complete service access.
 - g. Provide electrical inlets in sides and top of cabinet.
 - h. Multi-Position Capability: Ship for up-flow and horizontal right-hand discharge for quick conversion to down-flow or left-hand, horizontal air discharge. Optional Kit required for conversion to down-flow.
 - i. Dual Position Drain Pans: Drain pans shall be designed for up-flow, down-flow or horizontal applications. Deep, corrosion resistant plastic drain pans shall have dual pipe drains.
- 8. Options:
 - a. Electric Heat – Electric heat shall be field installed internal to unit cabinet. Helix wound Nichrome heating elements shall be exposed directly in air stream resulting in instant heat transfer, low element temperatures and long service life. Each element shall be equipped with accurately located limit control with fixed temperature off setting and automatic reset. Provide supplemental thermal cutoff limit control for positive protection in case of excessive temperatures. Provide thermal sequencer relay to bring elements on and off line, in sequence and equal increments, with time delay between each. Initiates and terminates blower operation. Heating control relay(s) shall be furnished as standard. Control box and access cover to be constructed of heavy gauge galvanized steel. Factory assembled with controls installed and wired. Electric heat low voltage controls shall plug-in to blower coil unit.
 - b. Circuit Breaker Models - Heaters shall be equipped with circuit breakers for overload and short circuit protection. Factory wired and mounted on electric heat unit. Current sensitive and temperature actuated. Manual reset. Circuit breakers shall qualify as disconnect, eliminating the need for field provided disconnect.
 - c. Single-Point Power Source Control Box - Control Box may be used with optional electric heat when single power supply is connected to multi-circuit electric heat. Field shall install external to the unit cabinet on either side or top. Construction to be heavy gauge steel, baked enamel finish, prepunched mounting holes, electrical inlet knockouts, and terminal strip. Provide removable cover for easy access.

2.03 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
- B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
- C. Warranty: Commencing on Date of Installation.
 - 1. Compressors: 5 years (limited).
 - 2. Integrated Modular Control: 3 years (limited).
 - 3. Other System Components: 1 year (limited).

PART 3: EXECUTION**3.01 EXAMINATION**

- A. Verification of Conditions: The Contractor shall be responsible for inspecting equipment prior to installation.

3.02 INSTALLATION

- A. Location: Install equipment as close as possible to the locations shown on the drawings. Equipment shall be installed according to applicable NFPA standards and the manufacturer's installation instructions.
- B. Connections: Connections, flexible duct connections, and duct transitions shall be as shown on the drawings. Flexible conduit and wiring connections shall be used on the AHU if local codes permit. A flexible connection shall be used at the drain connection.
- C. Mounting: Mount AHU in the location shown on the drawings using vibration isolators. Unit shall be mounted so as to provide access to hanger brackets and removable panels housing equipment and electrical connections. Piping shall not be run under the unit. Mounting shall provide for easy replacement of filters. Filters shall be in place prior to operation of the unit.

END OF SECTION

SECTION 15751
100% OUTSIDE AIR MAKE-UP UNITS

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Furnish and install dedicated 100% outside-air make-up units per plans and specifications. Capacity and Energy Efficiency shall not be less than scheduled. Unit shall be provided with factory installed options listed below.

1.03 SUBMITTALS

- A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements. Computer generated fan curves for each air handling unit shall be submitted with specific design operating point noted. A computer generated psychometric chart shall be submitted for each cooling coil with design points and final operating point clearly noted. Sound data for discharge, radiated and return positions shall be submitted by octave band for each unit. Calculations for required baserail heights shall be included.
- B. Product Data:
 - 1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Provide data of filter media, filter performance data, filter assembly, and filter frames.
- C. Manufacturer's Installation Instructions.

1.04 OPERATION AND MAINTENANCE DATA

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

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.
- B. Approved Manufactures:
 - 1. Trane
 - 2. Addison
 - 3. AAON
 - 4. Approved Equal

- C. Approvals
 - 1. Unit shall be design certified to conform to appropriate UL Standards by Applied Research Laboratories or other nationally recognized testing laboratory.

PART 2 - PRODUCTS

2.01 GENERAL DESCRIPTION

- A. Configuration: Fabricate as detailed on prints, including (as detailed on drawings):
- B. Performance: Conform to ARI 430. See schedules on prints.
- C. This Equipment may be combined with the Energy Recover Units specified elsewhere.

2.02 CABINET

- A. Cabinet shall be constructed of G-90 galvanized steel with minimum gauge thickness of: Bases – 16 gauge; Corner Posts and Tops – 18 gauge; Access Panels – 20 gauge.
- B. The interior of the indoor air side shall be thermally insulated with 1 inch thick fiberglass with an R-value of 4.2. A closed cell neoprene liner shall be installed on the underside of the base pan for noise reduction and weather seal to the roof curb.
- C. The cabinet shall be mounted on two steel rails to facilitate installation. The design of the cabinet shall allow access to the compressor and electrical panel on the PCA101 and larger units without impairing unit operation.

2.03 NON-RUST SOUND ATTENUATING BASE PAN

- A. Unit base pan shall be coated with a mastic compound to a uniform 1/2" wet depth and air dried to prevent rain or condensate from contacting steel on the bottom of the base pan.

2.04 PAINT FINISH

- A. Constructed of lot dipped galvanized G90 steel that is chemically treated with zinc phosphate, coated with 0.2 to 0.3 MIL polyurethane primer then finished with .07 to .08 MIL polyester top coat. Finish shall meet or exceeds 1,000 hour Salt Spray Test per ASTM B 17 97.

2.05 NON-CORRODING HARDWARE

- A. All exterior nuts, bolts and washers shall be stainless steel type 304.
- B. All exterior screws shall be either stainless steel type 304 or coated with Magnigard Silver 17, and shall withstand a minimum of 10,000 hours Salt Spray Test per ASTM B 117.

2.06 ASSEMBLY AND TEST

- A. The unit shall be completely factory assembled, prewired and thoroughly leak and safety control tested. After assembly, each unit shall be charged and run tested.

2.07 COMPRESSOR

- A. All compressors shall have crankcase heaters and the motors shall be equipped with internal overheat-overload protection.

2.08 COILS

- A. The condenser and evaporator coils shall be aluminum plate-finned formed on multiple rows of seamless copper tubing arranged in a staggered tube configuration.
- B. The tubes shall be mechanically expanded, firmly bonding the tube to the shoulder of each fin.

2.09 SLOPED STAINLESS STEEL CONDENSATE DRAIN PAN

- A. The condensate drain pan shall be sloped to comply with ASHRAE Standard 62-1089R and fabricated from stainless steel. The bottom then shall be insulated with 1" fiberglass insulation.
- B. The drain pan shall be furnished with single or dual MPT drain fittings positioned at the exterior of the cabinet.

2.10 CONDENSER AIR FAN AND MOTOR

- A. The condenser air fan shall be propeller type, electronically balanced and direct driven by a 1075 rpm PSC fan motor.

2.11 EVAPORATOR BLOWER AND MOTOR

- A. A forward-curved, statically and dynamically balanced DWDI centrifugal blower(s) shall be used for the evaporator air.
- B. Blower wheels shall be fabricated of galvanized or galvalume steel.
- C. Blower housings shall be fabricated of galvanized or epoxy coated steel.
- D. The blower wheel(s) shall be mounted on a solid steel shaft supported by sealed ball bearings. The shaft is to be driven by adjustable belt drive sheaves connected to a 1725 rpm motor with sealed ball bearings.

2.12 REFRIGERANT CIRCUIT

- A. Refrigerant circuit shall include condenser fan cycling head pressure control, accumulator, filter-drier, high pressure safety control (manual-reset), low pressure safety control/loss of charge protector (auto-reset), dual gauge connections for high and low pressure readings, sight glass-moisture indicator, and thermal-expansion valve.
- B. The expansion valve shall have adjustable superheat and distributors to meter the refrigerant evenly to the evaporator refrigerant circuits.

2.13 ELECTRIC CONTROLS

- A. Internally wired controls to include the compressor anti-short cycle timer, fan, blower and compressor motor contactors or starters mounted in a sheet metal control panel. The 24 volt control circuit to include a transformer and low voltage terminal board.

2.14 ADJUSTABLE AMBIENT THERMOSTAT

- A. A remote field supplied and installed system switch is required to start/stop the evaporator blower motor.

2.15 FILTERS

- A. Two inch, cleanable, metal mesh filters shall be installed in the filter rack.

2.16 ELECTRIC HEATERS

- A. The heaters are to be complete with open coil heating elements of high grade nickel-chromium, auto reset primary and manual reset secondary safety devices, blower interlock, and branch circuit fusing per NEC/UL.
- B. A hinged control panel shall be provided on the welded galvanized steel cabinet. A separate field installed and wired thermostat and disconnect for the electric heater is required. (Options include a differential air pressure switch, SCR Control and single point power termination.)

2.17 FULL PERIMETER CURB

- A. The unit manufacturers factory built curb shall meet the National Roofing Contractors Association August 1992 guidelines for roof mounted installations. Curb shall be 14 inches high and of all-welded, 16 gauge galvanized steel construction with a 2 x 4 pressure treated wood nailer strip furnished on the outside. (Burglar bars are an option)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION

**SECTION 15755
AIR HANDLING UNITS**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of all air handling units as specified herein.

1.03 RELATED WORK

- A. Air Terminal Units
- B. Fan Powered Terminal Units
- C. Ductwork
- D. Automatic Temperature Control

1.04 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 15000.
- B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
- C. Submit electrical requirements for power supply wiring. Include diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- D. Submit manufacturer's installation instructions under provisions of Section 15000.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 15000.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver product to site in factory-fabricated protected containers, with factory-installed shipping skids and lifting lugs.
- B. Store in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate unit for any purpose, temporary or permanent, until system has been cleaned and tested under observation.

1.08 WARRANTY

- A. For a period of one (1) year after owner acceptance of project, the manufacturer and vendor shall correct product defects due to the following:
 - 1. Failure to comply with specifications.
 - 2. Faulty materials, equipment, applications, and other items.
 - 3. Faulty workmanship.
- B. Defects corrected after energizing shall be accomplished at a time agreeable to owner.
- C. Product defects shall be replaced or corrected without charge to owner.

PART 2 - PRODUCTS**2.01 ACCEPTABLE MANUFACTURERS**

- A. Trane
- B. York
- C. Carrier
- D. Lennox
- E. Or approved equal

2.02 GENERAL

- A. Furnish complete air handling units as specified herein as designated on the drawing schedules. All standard and optional features shall be included within the unit unless otherwise specified.
- B. All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. All unit dimensions for each model and size shall be considered maximums.
- C. All units shall be of "draw-thru" design with coils, fans, motor/drive and drain pan completely contained within the unit cabinet.
- D. Electric heat can be in the draw-thru or the blow-thru configuration.
- E. Units shall be ETL listed in compliance with UL/ANSI Std. 1995.
- F. All coils shall be certified and tagged with an ARI 410 label.

2.03 CONSTRUCTION

- A. All units shall be fabricated of heavy gauge galvanized steel with a minimum G 60 zinc coating, able to withstand a 125 hour salt spray test per ASTM B-117. Panels shall be die-formed "multi-bend" construction for optimum strength and rigidity. All exterior panels shall be (single wall) (double wall) insulated with 3/4" thick, 4 pound per cubic foot skin, dual density fiberglass insulation, rated for a maximum air velocity of 3600 f.p.m. In addition to using adhesive complying with NFPA 90A, the insulation shall incorporate a secondary mechanical fastener attached to the unit casing wall (clench nail). Adhesive as the only method of fastening the insulation to the casing is not acceptable. Minimum thermal conductivity shall be 0.24. Insulation must meet all requirements of UL 181 and NFPA 90A. All units shall have minimum 1" duct collars

on discharge and return. Double wall liner shall be minimum 22 gauge G 60 Galvanized steel.

- B. All access panels shall be fully insulated and attached with (standard) (hinged with lift & turn) fasteners on at least two opposite sides. No single access panel shall be larger than 30" x 36" for safety and ease of handling. No coil or drain piping or electrical connections shall pass through any access panel.
- C. Each unit shall be furnished with a one-piece heavy gauge (galvanized steel) (304 stainless steel) drain pan with welded corner construction. All interior galvanized steel drain pan surfaces shall be coated with "black mastic" to retard corrosion and enhance insulating efficiency.
- D. All single wall units shall be provided with 9/16" diameter hanger rod holes in the top and bottom panels for "through-bolt" type suspension installation. Double wall units require a trapeze for hanging. (Rubber-in-shear) (Spring) type unit mounting vibration isolators shall be provided by the unit manufacturer.

2.04 FAN ASSEMBLY

- A. All units shall be furnished with double inlet forward curved centrifugal blowers statically and dynamically balanced for smooth operation. All blower wheels shall have two set screws and shall be mounted on solid steel shafting rotating in ball bearings with a minimum design average life of 100,000 hours. All standard blower assemblies shall have resilient mounted cartridge type permanently lubricated ball bearings. All heavy duty blower assemblies shall have relubable type rigid mounted pillow block ball bearings.

2.05 FAN MOTOR AND DRIVE ASSEMBLY

- A. All fan motors shall be standard NEMA design motors of the horsepower listed in the equipment schedule. All motors shall be 1750 RPM, 60 hertz (ODP) (ODP E+) single speed motors rated for continuous duty. All motors shall be reversible rotation type.
- B. Three phase motors shall be "across-the-line" start type in 56 Frame size up through two horsepower. Three horsepower and larger shall be standard "T" frame with rigid mount.
- C. All motors shall be mounted on an adjustable base.
- D. All fan drive assemblies shall include an adjustable pitch motor pulley, a fixed pitch blower pulley and a standard cross section "V-belt". All fan drives shall be selected at a minimum service factor of 1.2.

2.06 COILS

- A. All coils shall be certified and tagged with an ARI 410 label.
- B. All coils shall be 1/2" O.D. seamless copper tubes with collared and corrugated aluminum fins. All tubes shall be mechanically expanded to provide an efficient bond between tube and fin. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Valve core type vent fittings shall not be accepted.
- C. All heating and cooling coils shall have minimum rows required to meet the specified capacity.

- D. All coils shall be hydrostatically tested with air under water at 350 psig minimum pressure.
- E. Direct expansion coils are tested to 500 PSIG pressure and are factory sealed and charged with a minimum of 5 PSIG nitrogen or refrigerated dry air.

2.07 OPTIONS

- A. Coil casing shall be fabricated from 304 Stainless Steel.
- B. Fins shall be 0.0075 aluminum.
- C. Fins shall be 0.0075 Copper.
- D. 0.025 tube wall on water coils.

2.08 FILTER RACK ASSEMBLY

- A. All units shall be furnished with a flat filter rack with hinged access on both sides designed to accept either 1" or 2" nominal standard sized filters. All units shall be provided with nominal 2" pleated filters factory installed. One complete set of spare pleated filters shall be provided for each unit.

2.09 ELECTRICAL CONTROL

- A. The unit fan motor shall be completely factory wired to an external electrical enclosure. Each unit shall include fan motor operating control with 24 volt control voltage. Each unit shall include motor circuit fusing, control circuit transformer with primary fusing and terminal strip for connection of field wiring.
- B. A main incoming power fused disconnect switch shall be factory furnished and wired by the unit manufacturer for single point power connection.

2.10 ELECTRIC RESISTANCE HEATER

- A. Where shown on the plans, the unit manufacturer shall furnish an electric resistance heating assembly with the heating capacity, voltage and steps as shown in the schedule. The heater assembly shall be designed and rated for installation to the air handling unit in the draw-thru blow-thru configuration without the use of duct extensions or transitions between the unit and the heater assembly. The heater assembly shall be factory assembled to the air handling unit and completely factory wired.

The heater/unit assembly shall be listed for zero clearance meeting all N.E.C. requirements and be ETL listed in compliance with UL/ANSI Std. 1995.
- B. All heating elements shall be open coil type of 80/20 nichrome wire mounted in ceramic insulators and housed in an insulated heavy gauge galvanized steel housing. All elements shall terminate in a machine staked stainless steel terminal secured with stainless steel hardware. The element support brackets shall be spaced no greater than 3-1/2" on center. All internal wiring shall be rated for 105°C minimum.
- C. All heaters shall include overtemperature protection. All heaters shall include a non-adjustable airflow switch.

- D. An incoming line power distribution block shall be provided. The power distribution block shall be designed to accept incoming power wiring capable of carrying 125% of the calculated load current.

In addition to the above, electric heaters shall include the following options:

- Single point power connection, including power to blower motor
- Main incoming power disconnect fused
- Main fusing per N.E.C
- Magnetic contactors wired for disconnecting operation
- Fan interlock relay, or P.E. switch
- Quiet operating magnetic contactors (24 volt control only)
- Class II 24 volt control transformer
- Primary and/or secondary control transformer fusing
- P.E. switch, direct or reverse acting
- Solid state relay with (4-20 ma) (thermistor) (0-135 ohm) (0-16 VDC) (6-9 VDC) control
- Thermostat, duct or wall mounted
- Step controller with electronic control
- System status pilot lights
- Remote component mounting panel
- Fan motor fusing
- Fan motor relay or starter with heater interlock contacts required on single point power connection
- Pilot duty 24 volt fan relay
- De-rated elements
- Fin tubular elements

PART 3 — EXECUTION

3.01 INSTALLATION

- A. Install according to manufacturer's requirements, shop drawings, and Contract Documents.
- B. Install air handler alignment on concrete foundations on vibration isolation as called for on drawings.
- C. Arrange the piping on each vessel to allow for dismantling the pipe to permit coil removal and cleaning.
- D. Arrange unit for filter exchange without interference.
- E. Coordinate electrical installation with electrical contractor.
- F. Coordinate controls with control contractor.
- G. Provide all material required to ensure a fully operational and functional air handler.

END OF SECTION

**SECTION 15757
DUCTLESS MINI-SPLIT SYSTEM**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of all mini-split heat pumps as specified herein.

1.03 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 15000.
- B. Shop drawings shall indicate assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
- C. Submit electrical requirements for power supply wiring. Include diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- D. Submit manufacturer's installation instructions under provisions of Section 15000.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 15000.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver product to site in factory-fabricated protected containers, with factory-installed shipping skids and lifting lugs
- B. Store in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate unit for any purpose, temporary or permanent, until system has been cleaned and tested under observation.

1.08 WARRANTY

- A. The units shall have a manufacturer's parts and defects warranty for a period five (5) years from date of installation. The compressor shall have a warranty of seven (7) years from the same date of installation. 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. This warranty does not include labor.

PART 2 - PRODUCTS**2.01 ACCEPTABLE MANUFACTURERS**

- A. Samsung (Basis of Design)
- B. LG
- C. Panasonic
- D. Mitsubishi
- E. Or approved equal

2.02 INDOOR UNITS

- A. General:

The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board, fan and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function after power interruption. Indoor unit shall be purged with dry air before shipment from factory.
- B. Unit Cabinet:
 - 1. The casing shall have a smooth front, white finish – Munsell 1.0Y 9.2/0.2.
 - 2. Multi directional drain connection and refrigerant piping, offering three (3) direction pipe alignments for all refrigerant piping and two (2) direction pipe alignments for condensate draining shall be standard.
 - 3. There shall be a separate, metal installation-plate that secures the indoor unit firmly to the wall. The installation-plate shall be securely attached to the wall using appropriate anchor method. Installing contractor shall determine the best method and be responsible for proper mounting of the installation plate to the wall.
- C. Fan:
 - 1. The indoor unit fan shall be an assembly with a line-flow fan direct driven by a single motor.
 - 2. The fan shall be statically and dynamically balanced and be powered by a motor with permanently lubricated bearing.
 - 3. A manual adjustable guide vanes shall be provided with the ability to change the airflow from side to side (left to right).
 - 4. An integral, motorized, multi-position, horizontal air sweep flow louver shall provide for uniform air distribution, up and down. Five (5) positions plus Auto and Swing shall be provided, controlled from the remote controller.
- D. The indoor fan shall operate at one of five (5) speeds: Super High, High, Medium, Low, and Quiet plus Auto Fan Mode for models up to 18,000 BTU/h, and four (4) speeds: Powerful, High, Medium and Low plus Auto Fan Mode for the 24,000 BTU/h model. All speeds shall be selected from the remote controller
- E. Filter:
 - 1. Return air shall be filtered by means of easily removed, washable, Catechin, Antioxidant Pre-filter and an Anti-allergy enzyme filter – blue, pleated type.

- F. Coil:
1. The indoor unit 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 phoscopper or silver alloy.
 4. The coils shall be pressure tested at the factory.
 5. A sloped, corrosion resistant condensate pan with drain shall be provided under the coil.
 6. An optional drain pan level switch (DPLS1), designed to connect to the control board, shall be provided if required, and installed on the condensate pan to prevent condensate from overflowing.
- G. Electrical:
1. The unit electrical power shall be 208-230 volts, 1-phase, 60 hertz.
 2. The system shall be equipped with A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire, 14 ga. AWG connection plus ground.
 3. The indoor unit shall not have any supplemental electrical heat elements.

2.03 CONTROL

- A. General:
1. The unit shall have a wireless hand held remote controller to perform input functions necessary to operate the system.
 2. The wireless hand held controller shall have a Power On/Off switch, Mode
 3. Selector – Auto, Cool, Heat, Dry Modes - Temperature Setting, Timer Control with Clock, Fan Speed Select and Vane / Airflow Direction selector. Controller shall have a programmable Smart Set button for pre-selected Temperature, Fan Speed, and Vane position settings.
 4. The indoor unit shall perform Self-diagnostic Function and Check Mode switching.
 5. Temperature changes shall be by 1°F increments with a range of 61 - 88°F (16- 31°C).
 6. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wireless or a wired controller, providing emergency operation and controlling the outdoor unit.
 7. The system shall be capable of automatically restarting and operating at the previously selected conditions when the power is restored after power interruption.
 8. The indoor unit shall have the option of either a wireless or wired wall mounted remote controller to be ordered separately:
 - a. Wireless, wall mounted remote controller kit (MHK1)
The Wireless, wall mounted remote controller kit (MHK1) shall consist of a wireless, wall mounted controller (MRCH1), a wireless receiver (MIFH1) and a cable (MRC1) to connect the receiver to the indoor unit. The controller shall be white in color with a light-green LCD display and a backlight feature. The MRCH1 shall consist of four Function buttons below the display, and Increase/Decrease Set Temperature

buttons and a Hold button to the right of the display. The controller shall have a built-in temperature sensor and a battery holder, using two AA alkaline batteries. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C), and temperature changes shall be by increments of 1°F (0.5°C).

2.04 OUTDOOR UNITS

A. General:

1. The outdoor units are specifically designed to work with the indoor units. The outdoor units must have a thermally fused powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.

B. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Assembly hardware shall be cadmium plated for weather resistance.
2. Cabinet color shall be Munsell 3Y 7.8/1.1.
3. Two (2) mild steel mounting feet, traverse mounted across the cabinet base pan, welded mount, providing four (4) slotted mounting holes shall be furnished. Assembly shall withstand lateral wind gust up to 155 MPH to meet applicable weather codes.

C. Fan:

1. The unit shall be furnished with a direct drive propeller type fan.
2. The outdoor unit fan motor shall be a direct current (DC) motor and have permanently lubricated bearings.
3. The fan motor shall be mounted for quiet operation.
4. The fan shall be provided with a raised guard to prevent contact with moving parts.
5. The outdoor unit shall have horizontal discharge airflow.

D. Coil:

1. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil shall be protected with an integral metal guard.
3. Refrigerant flow from the outdoor unit shall be regulated by means of an electronically controlled, precision, linear expansion valve.
4. Outdoor unit shall be pre-charged with sufficient R-410a refrigerant for up to twenty five (25) feet of refrigerant piping for capacities up to 18,000 BTU/h, and up to thirty three (33) feet of refrigerant piping for capacities above 18,000 BTU/h.
5. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better

than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a 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.

6. All refrigerant connections between outdoor and indoor units shall be flare type.

E. Compressor:

1. The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type manufactured by Mitsubishi Electric Corporation.
2. The compressor motor shall be direct current (DC) type equipped with a factory supplied and installed inverter drive package.
3. The outdoor unit shall be equipped with an accumulator.
4. The compressor will be equipped with internal thermal overload protection.
5. The outdoor unit must have the ability to operate over the full capacity range with a maximum height difference of 40 feet and have refrigerant tubing length of 65 feet for capacities up to 15,000 BTU/h and a maximum height difference of 50 feet and have refrigerant tubing length of 100 feet for capacities above 15,000 BTU/h between indoor and outdoor units.
6. There shall be no need for line size changes. Filters, sight glasses, and traps shall not be used, and no additional refrigerant oil shall be required.
7. The compressor shall be mounted so as to avoid the transmission of vibration.

F. Electrical:

1. The outdoor unit electrical power supply shall be 208/230 volts, 1-phase, 60 hertz.
2. The unit shall be capable of satisfactory operation within voltage limits of 187 volts to 253 volts.
3. The outdoor unit shall be controlled by microprocessors located in the indoor unit and outdoor unit. A 12 to 24 volt DC data stream shall communicate between the units providing all necessary information for full function control.

PART 3 — EXECUTION

3.01 INSTALLATION

- A. Install according to manufacturer's requirements, shop drawings, and Contract Documents.
- B. Coordinate electrical installation with electrical contractor.
- C. Coordinate controls with control contractor.
- D. Provide all material required to ensure fully operational and functional heat pumps.

END OF SECTION

SECTION 15800
AIR DISTRIBUTION DEVICES

PART 1 GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of all air distribution devices as indicated on the drawings and as specified herein for a complete and operable system.

1.03 RELATION TO OTHER WORK

- A. Coordinate with work of the ceiling, drywall and plastering trades as required to insure an orderly progression of work and a first class finished system with respect to placement, alignment, finish, general fit and absence of conflict with lighting systems and fire protection systems.

1.04 DESIGN CONDITIONS

- A. Acoustical: Noise produced at each diffuser, register, grille or other air distribution device shall not exceed a noise criteria level of NC 35 based on sound pressure levels in db re 0.0002 microbars unless otherwise indicated. Coordinate air distribution devices, sound attenuation measures and equipment actually provided to insure that this design constraint is not exceeded by the system installed.
 - 1. Exceptions: Offices - NC 35, Classrooms - NC 30, Practice Rooms NC 30, Cafetorium - NC 25, Music Room - NC 25 and any particular rooms or areas which are normally occupied by other than maintenance staff or service staff and which may be noted on the drawings as requiring lower NC criteria.
- B. Pressure Drop: Pressure drop across any air distribution device shall not exceed 0.15 in wg static pressure unless otherwise indicated.
- C. Guaranty: Air distribution equipment shall be guaranteed by the manufacturer to operate without excessive noise and with velocities in the five foot occupancy zone, when handling air with temperature differentials as high as 25 degrees, not to exceed 30 fpm at a 2 degree difference, 50 fpm at 1½ degree difference, of 75 fpm at a 1 degree difference when operating within average 75 degree room temperature and measured no closer than 6 inches from a wall surface.

1.05 SHOP DRAWINGS

- A. Refer to the requirements of Section entitled "General Mechanical Provisions".

1.06 MANUFACTURER

- A. Metalaire
- B. Titus

AIR DISTRIBUTION DEVICES
SECTION 15800 - 1

- C. Nailor
- D. Approved equal.

1.07 OTHER REQUIREMENTS

- A. All aluminum is to be extruded unless otherwise indicated.
- B. All devices in a fire rated ceiling shall be steel.
- C. Appearance: Each air distribution device which has a portion thereof (frame, core, etc.) exposed to view in the finished area shall have a factory applied finish which matches and is compatible with the color of the surrounding surface on which the device is installed. Colors must be approved by Architect prior to device fabrication.
- D. All louvers, dampers and/or shutters shall be rated by their manufacturer in accord with AMCA Standard 500-74.
- E. Integral Components: All dampers, blank-off baffles and other companion devices which form an integral part of air distribution device shall be factory made items produced by the manufacturer of air distribution device.
- F. Louvers: Louvers are specified in another division but for reference may also be indicated on mechanical drawings and are designated by the letter "L".
- G. Door Grilles: Door grilles are specified in another division but for reference may also be indicated on mechanical drawings and may be designated by the letters "DG".
- H. Linear Diffuser Continuity: Where continuous linear supply and return devices are shown as abutting one another in a single direction, then the total unbroken visible length of the linear supply/return device shall equal the sum of the nominal lengths of the abutting devices. Install with plenum per manufacturer recommendation.

PART 2 - PRODUCTS**2.01 GENERAL**

- A. Provide the following air distribution devices as applicable to this project. Refer also to air distribution device schedule(s) which may be shown on drawings.

2.02 OTHER REQUIREMENTS

- A. All devices must each comply with the applicable portions of the Air diffusion Council (ADC) Equipment Test Code 1062R4 "Certification, Rating and Test Manual", the air movement and Control Association, Inc. (AMCA) Standard 500 "Test Method for Louvers, Dampers and Shutters" and the "National Fire Protection Association" (NFPA) Standard 90A "Installation of Air Conditioning and Ventilating Systems".
- B. Provide ceiling and/or linear diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of diffuser.

- C. Diffusers, grilles and registers installed in fire rated ceiling, or floor/ceiling assemblies shall be constructed of steel.
- D. Mounting Screws: Where grilles, diffusers or registers are specified which require mounting screws visible from the face of the device these screws shall be furnished with the air distribution equipment and be finished at the factory to match the finish on the grille, diffuser or register in which they are to be used.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install neatly where indicated in accord with manufacturer's recommendations and in accord with SMACNA recommendations and as otherwise indicated.
- B. Properly test, balance and adjust to produce quiet, draftless operation to best degree possible.
- C. Balance supply air to each grille with accessible manual volume damper, if the branch duct to the grille is not accessible (hard ceiling) then install Bowden cable control from young regulator company and mount the controller on top of the grille or on the adjacent wall.

3.02 INSTALLATION

- A. Rectangular Diffusers: Where diffusers are the lay-in type, they shall be supported by the inverted T-bar suspension system but all ducts connected thereto shall be supported independently of the ceiling as specified under Section entitled "Ductwork". Surface mounted diffusers shall be supported by the duct run-outs or drops where sheet metal ducts are indicated and by separate hangers where flex run-outs are indicated. All rectangular ceiling diffusers shall be installed with their lines parallel and perpendicular to the building line and properly aligned with the ceiling.
- B. Sidewall Grilles and Registers: Mount securely to the duct system flanges using finish screws and in accordance with accepted good practice.
- C. Ceiling mounted Exhaust and Return Registers/Grilles: Mount as specified hereinbefore for surface mounted ceiling diffusers except use finished screws provided and secure to duct and finished ceiling (or finished ceiling for non-ducted returns) in accordance with the manufacturer's instructions. Where required to provide adequate support for non-ducted registers or grilles, provide appropriate mounting frame for incorporation into the ceiling system.
- D. Install all outlets and inlets as recommended by the manufacturer; in accordance with recognized industry practices; to insure that products serve intended functions.
- E. Locate ceiling air outlets and inlets as indicated on the drawings. Unless otherwise indicated, locate units in center of acoustical ceiling modules. Install square and parallel with partitions, ceiling grid members, etc.
- F. Spare Parts: Furnish to Owner, with receipt, 3 operating keys for each type of outlet and inlet that require them.

- G. Install all supply air diffusers with accessible Manual Volume Damper or with Young's Regulator if it is not accessible from ceiling.

3.03 PROTECTION OF WORK UNTIL FINAL ACCEPTANCE

- A. Coordinate the installation of the air distribution equipment with related work and finishing of adjacent surfaces to prevent damage to the devices or adjacent finishes. Protect the finish of all air distribution equipment until final acceptance. Replace or repair to the Architect's satisfaction any damaged equipment.

END OF SECTION

**SECTION 15829
IN-LINE FANS**

PART I - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of the following items as specified herein, including, but not limited to, the following:
 - 1. Provide all fans at the locations shown on the drawings or as scheduled and/or specified in the following paragraphs.
 - 2. Provide support racks or hangers as specified or detailed on drawings.

1.03 SUBMITTALS

- A. Alternates may or may not substantially change scope of general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

1.04 CERTIFICATIONS

- A. Fan performance shall be certified in accordance with the appropriate Air Movement and Control Association (AMCA) Standards.

PART 2 - MATERIALS

2.01 IN-LINE FANS

- A. Duct mounted in-line fans shall be of the centrifugal direct or belt driven in-line type as scheduled. The fan housing shall be constructed of heavy gauge galvanized steel and shall include square duct mounting collars or square to round adapters.
- B. The door on one side of the housing shall be equipped with a hingeable service door assembly. The door assembly must swing out for cleaning, inspection, or service without dismantling the fan in any way.
- C. Provide two removable service doors located perpendicular to the motor mounting panel. The service doors must be of sufficient size to permit easy access to all interior components.
- D. The fan wheel shall be of the aluminum centrifugal type. Wheels shall be dynamically and statically balanced and shall overlap the spun inlet venturi for maximum performance.
- E. The motor and drives shall be isolated from the air stream. Motors shall be of the heavy duty type with permanently lubricated, sealed ball bearings. The wheel shaft shall be

ground and polished shafting mounted in heavy duty permanently sealed pillow block bearings. Drives shall be sized for a minimum of 165% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulleys shall be adjustable for final system balancing.

- F. Flexible wiring leads shall be provided from the fan motor to an external mounted junction box and disconnect switch permitting access for service without disconnecting the field wiring. All fans shall bear the AMCA Certified Ratings Seal for both air and sound performance.
- G. In-line fans that exceed ten (10) sones shall be wrapped with sound lagging blanket type wrap. Lagging shall be 2" thick three-pound density wrap.
- H. Acceptable Manufacturers
 - 1. Greenheck
 - 2. Loren Cook.

PART 3 - EXECUTION

3.01 EQUIPMENT

- A. Ensure air distribution equipment is wired properly, with rotation in direction indicated and intended for proper performance.
- B. Furnish to Owner, with receipt, one spare set of belts for each belt driven equipment item.
- C. Provide necessary anchorage and supports to prevent vibration and/or ceiling deflection.

END OF SECTION

**SECTION 15838
POWER VENTILATORS**

PART 1 – GENERAL**1.01 RELATED DOCUMENTS**

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal ventilators.
 - 2. Ceiling-mount ventilators.
 - 3. Propeller fans.

1.03 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on sea-level conditions.
- B. Operating Limits: Classify according to AMCA 99.

1.04 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material gages and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- B. Operation and Maintenance Data: For power ventilators to include in maintenance manuals specified in Division 1.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705 for kitchen exhaust fan. UL 762.

1.06 DELIVERY STORAGE AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.07 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.08 EXTRA MATERIAL

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents
- B. Belts: two sets for each belt-driven unit.

PART 2 – PRODUCTS**2.01 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Centrifugal Roof Ventilators:
 - a. Cook, Loren Company
 - b. Greenheck Fan Corp.
 - c. Penn Barry Ventilation Companies. Inc.
 - d. Power Line
 - 2. Ceiling-Mounting Ventilators:
 - a. Breidert Air Products, Inc.
 - b. Broan Mfg. Co., Inc.
 - c. Cook, Loren Company
 - d. Greenheck Fan Corp.
 - e. JennFan; Div. of Breidert Air Products, Inc.
 - f. NuTone Inc.
 - g. Penn Barry Ventilation Companies. Inc.
 - h. Power Line
 - 3. Propeller Fans:
 - a. Aerovent; a Twin City Fan Company
 - b. Breidert Air Products, Inc.
 - c. Chicago Blower Corp
 - d. Cook, Loren Company
 - e. Greenheck Fan Corp.
 - f. JennFan; Div. of Breidert Air Products, Inc.
 - g. New York Blower Company (The)
 - h. Penn Barry Ventilation Companies. Inc.
 - i. Power Line

2.02 CENTRIFUGAL VENTILATORS

- A. Centrifugal ventilators shall resist a 02 wind velocity 160 mph, I-1.0, at EHPA buildings only. Refer to Section 1 or S99.2.5 for additional information.
- B. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: (Kitchen exhaust and Science Lab exhaust) Provide spun-aluminum discharge baffle to direct discharge air upward, with rain drains.
- D. Fan Wheels: Machine cast aluminum hub and wheel with backward-inclined blades. Balanced in accordance with AMCA Standard 204.96.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearing: Permanently lubricated, permanently sealed, and self-aligning ball bearings.
 - 3. Pulleys: Cast-iron adjustable pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.

2.03 ACCESSORIES

- A. Variable Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.
- B. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit
- C. Bird Screens: Removable, 1/2-inch (13mm) mesh, aluminum or brass wire.
- D. Dampers Counter balanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- E. Motorized Dampers: Parallel-blade dampers mounted in curb base; factory set to close when fan stops.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-(40-mm) thick, rigid, fiberglass insulation adhered to inside walls and 1-1/2-inch (40mm) wood nailer. Size as required to suit roof opening and fan base.
- G. Configuration: Built-in raised cant and mounting flange.
- H. Overall height: 16 inches (400 mm).
- I. Sound Curb: Curb with sound-absorbing insulation matrix.
- J. Pitch mounting: Manufactured curb for roof slope.

- K. Metal Liner: Galvanized steel.
- L. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance.
- M. Mounting Pedestal: Galvanized steel with removable access panel.
- N. Vented Curb: Unlined with louvered vents in vertical sides.

2.04 CEILING-MOUNTING VENTILATORS

- A. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. · Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Plastic, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent 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. Isolation
 - 5. Rubber-in-shear vibration isolators.
- G. Provide In-o-Vate Technologies Dryer Vent Wall.

2.05 IN-LINE CENTRIFUGAL FANS

- A. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Driven Units: Motor encased in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure 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. Accessories:
 - 1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 - 2. Companion Flanges: For inlet and outlet duct connections.
 - 3. Fan Guards: 1/2- by 1-inch (13- by 25-mm) mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - 4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.06 MOTORS

- A. Refer to Division 15 Section "Motors" for general requirements for factory-installed motors.
- B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- C. Enclosure Type: Open dripproof.

2.07 SOURCE QUALITY CONTROL

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

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support utility set fans and in-line centrifugal fans using spring isolators having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Division 15 Section "Mechanical Vibration Controls."
- C. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.
- D. Install floor-mounting units on concrete bases. Concrete, reinforcement, and form work requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- E. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 Section "Roof Accessories" for installation of roof curbs.
- F. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

- G. Support suspended units from structure using threaded steel rods and spring hangers. Vibration-control devices are specified in Division 15 Section "Mechanical Vibration Controls.
- H. Install units with clearances for service and maintenance.
- I. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.03 GROUND EQUIPMENT

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL486A and UL 486B.

3.04 FIELD QUALITY CONTROL

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

- G. Shut unit down and reconnect automatic temperature-control operators. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Shut unit down and reconnect automatic temperature-control operators.
- I. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- J. Replace fan and motor pulleys as required to achieve design airflow.
- K. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.05 ADJUSTING

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

3.06 CLEANING

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

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Review data in maintenance manuals. Refer to Division Section "Closeout Procedures."
 - 3. Review data in maintenance manuals refer to Division Section "Operation and Maintenance Data."
 - 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

**SECTION 15841
LOW PRESSURE DUCTWORK**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. Provide complete duct systems as indicated. Systems shall include, but not be limited to, the following: Outside air, exhaust air and air conditioning supply and return air duct systems as shown on drawings. Drawing scales prohibit the indication of all offsets, fittings and like items; however, these items shall be installed as required for the actual project conditions at no change in contract price.
- B. Items Included: This section generally includes, but is not limited to, the following major items.
1. Low pressure sheet metal ductwork.
 2. Low pressure flexible ducts.
 3. Low pressure fiberglass air ducts.
- C. Examples of application of low pressure ductwork which may be required are as follows:
1. Supply air systems.
 2. Return air systems.
 3. Outside air, make-up air and ventilation air systems.
 4. Exhaust air systems.
- D. Air distribution devices shall not drop directly out of main trunk ducts. Provide offsets as required to minimize main trunk duct air-borne noise being detected through air distribution devices.

1.03 RELATION TO OTHER WORK

- A. Coordinate shop drawings ordering, delivery and placement if all items affecting the duct systems including but not limited to the following items: Air handling units, exhaust fans, supply fans, sound attenuators, duct mounted coils, access panels, air distribution devices, fire dampers, outside air louvers, hoods, filters, roof curbs, structural framing, roof construction, roofing and the work of all trades to insure an orderly and timely progression of the work. Refer to the requirements of Section entitled "General Provisions".
- B. Refer to other sections which may describe additional sound attenuation measures which may relate to this section.

1.04 SHOP DRAWINGS

- A. Refer to Section entitled "General Mechanical Provisions". Include complete data on: All prefabricated duct and fittings; duct liner including mechanical fasteners and adhesives; duct sealing materials; and all other items. If required by Architect, prepare and submit for approval completely detailed shop drawings of supply and return ductwork from any or each air handling unit through its transitions, bends and elbows unit such ducts are extended

beyond the air handling unit equipment area and/or congested areas; these shop drawings will not be required unless specifically called for elsewhere or unless significant deviation from the Drawings is necessitated by the equipment provided.

1.05 OTHER REQUIREMENTS

- A. Provide all ductwork and components thereof in accord with manufacturer's recommendations.
- B. All ductwork dimensions indicated are nominal free clearance internal dimensions which do not include insulation thickness.
- C. Manufacturers:
 - 1. Lindab
 - 2. FlexMaster

1.06 DEFINITIONS

- A. "SMACNA" means "Sheet Metal and Air Conditioning Contractors National Association, Inc."
- B. Low Pressure Ductwork: Any and all ductwork conveying air or other, gases at velocities less than 2000 fpm and static pressure less than 2.0 inches wg. This ductwork may also be referred to in these specifications as "Low Velocity Ductwork". SMACNA "HVAC Duct Construction Standards, Metal and Flexible", latest edition, shall govern construction of this ductwork unless otherwise specified.
- C. High Pressure Ductwork: Any and all ductwork conveying air or other gases at velocities equal to or greater than 2000 fpm or static pressure equal to or greater than 2.0 inches wg. This ductwork may also be referred to in these specifications as "High Velocity Ductwork" or "Medium Pressure Ductwork", but shall be considered, in either terminology, to fall within pressure/velocity class (PVC designation) 3 to 10. SMACNA "HVAC Duct Construction Standards, Metal and Flexible", latest edition, shall govern construction of this ductwork unless otherwise specified.

1.07 PRESSURE / VELOCITY CLASSIFICATIONS

- A. Pressure and velocity classifications (hereinafter called "PVC") for ducts are defined as follows:

PRESSURE DESIGNATION	PRESSURE CLASS	RELATIVE PRESSURE	STATIC PRESSURE	VELOCITY
10	High	+	10"	2000 up
6	Medium	+	6"	2000 up
4	Medium	+	4"	2000 up
3	Medium		3"	4000 dn
2	Low		2"	2000 dn
1	Low		2"	2000 dn
1/2	Low		1/2"	1500 dn

- B. See Part 3, EXECUTION, of this section for duct sealing requirements.

PART 2 – PRODUCTS**2.01 GENERAL**

- A. Materials shall comply with current SMACNA standards.

2.02 MICROBIAL LINED FIBERBOARD DUCT

- A. Can be utilized everywhere except for make-up air intake up to air handler, exhaust, kitchen hood and dishwasher exhaust.

2.03 LOW PRESSURE SHEET METAL DUCTWORK

- A. Material: Prime quality forty-eight inch wide require tight coat galvanized steel conforming to the requirements of ASTM A-526.
- B. Reinforcing, Cross Breaking, Seams, Joints: Be in accord with latest SMACNA construction standard for low pressure sheet metal duct.
- C. Gauge: As required by SMACNA for the dimensions and pressure/velocity classification involved.
- D. Ductwork shall be rectangular or round as indicated on drawings.
- E. Rectangular rigid sheet metal ductwork shall not be internally lined with acoustical thermal duct liner unless specifically noted otherwise.

2.04 ACOUSTICAL THERMAL DUCT LINER

- A. Line ductwork where indicated. Dimensions indicated are net inside dimensions. Liner shall be one inch thick, three pound density fiberglass duct liner with the surface in contact with moving air stream stabilized with black pigmented neoprene. Duct liner shall comply with requirements of NFPA 90A as to flame spread and smoke developed ratings.
- B. Acceptable Manufacturers: Johns Manville, Microtex; PPG Industries, Testrafine; or Certain-Teed/Saint Gobain, Coated Ultralite.
- C. Attachment: Attach to the interior of sheet metal ducts using a full coverage coat of Foster's 85-20 adhesive and mechanical fasteners applied as follows:
 - 1. Horizontal Ducts: Install mechanical fasteners on underside of the tops of ducts over twelve inches in width and on the insides of ducts over sixteen inches in height.
 - 2. Vertical Ducts: Install mechanical fasteners on all duct surfaces exceeding twelve inches.
 - 3. Fastener Spacing: Install fasteners within two inches of the leading edge of each duct section and within three inches of the leading edge of cross joints in insulation within any given duct section. Pins shall thereafter be spaced at not more than fifteen inches on centers. Pins shall be installed in strict accordance with manufacturer's instructions.
- D. Edge Stabilization
 - 1. All exposed edges and the leading edge of all cross joints of liner shall be coated with Foster's 30-36.

2.05 LOW PRESSURE FLEXIBLE DUCTS**A. General:**

1. The inclusion of flexible ducts in this specification shall not be construed as approval of use on the project unless specifically shown on the Drawings.
2. Where used, provide in factory finished lengths not in excess of lengths required to make kink-free connections with minimum air pressure drop.

B. Insulated flexible ducts: Flexible duct shall be factory fabricated preinsulated type with seamless vapor barrier. Duct shall bear UL 181 Class 1 Air Duct label and shall comply with NFPA 90A and 90B Fiberglass insulation nominal 1" thickness with thermal conductance of 0.23 BTU/hr-ft²-°F maximum at 75°F mean temperature. Flexible duct shall have an operating range of minus 0.5" w.g. to plus 2" w.g. Core shall be continuous and consist of aluminized mylar laminated to corrosion resistant steel wire helix. Vapor barrier perm rating shall be 0.17 maximum per ASTM E96-A. Maximum working velocity shall be 4000 FPM. Flexible duct shall be Genflex SLR-25, Clevaflex Type KQ, Wire Mold type WG or approved equal.

C. Uninsulated flexible ducts, steel Flexible ductwork shall be constructed of all metal one ply hot-dipped galvanized steel, closely corrugated for strength and flexibility, with seams interlocked, folded flat and knurled to insure tightness. Duct shall be listed as #UL181 Products equal to "Flexible Air Duct", Class 1, and NFPA 90A. Clevaform Type GS are acceptable.

D. Uninsulated flexible ducts, aluminum: Flexible air ducts shall be all metal construction consisting of a bonded two-ply aluminum laminate mechanically corrugated for strength and air tightness. Flexible air duct shall be of semi-rigid construction capable of being easily hand preformed into required elbows or offsets without subsequent sagging or droop. Duct shall be listed #UL181 "Flexible Air Duct", Class 1 and NFPA 90A. Acceptable manufacturers are Clevaflex Type 12, Genflex Type AFG, or approved equal.

E. Round branch take-off fittings for flexible duct:

1. Round duct branch take-off fitting shall be made of galvanized sheet metal designed for twist-in installation and to assure minimum air loss at the take-off. The fittings shall be of the conical covering type to reduce the pressure drop through the fittings. Provide a raised bead on the throat of the fitting to assure a tight positive connection.
2. Provide each fitting with the following:
 - a. Lockable quadrant damper.
 - b. 45-degree extractor scoop.
 - c. Insulation guard where used with internally lined ductwork.
3. Provide these "spin-in" type fittings at all connections between rigid sheet metal duct and flexible duct at the upstream end of the flexible duct.

2.06 DISHWASHER

A. Exhaust ducts which are intended to remove air laden with water vapor from dishwashing equipment shall be as follows:

1. Material:
 - a. Concealed ductwork shall be constructed of 16 gauge type 304 stainless steel.
 - b. Exposed ductwork shall be constructed of 16 gauge (min.) ANSI type 304 stainless steel with No. 4 polished finish.

2. Seams and Joints: Fabricate duct in shapes, fittings and sizes indicated and weld all seams and joints.
3. Changes in Shape or Direction: Construct all changes in shape or direction in such a manner as to prevent the formation of any traps or pockets which might collect water. Slope duct down toward dishwasher.
4. Standards: Comply with latest SMACNA construction standard which covers this type of duct system.

PART 3 EXECUTION

3.01 GENERAL

- A. All duct systems shall be free of noise, chatter, vibration and pulsation under all conditions of operation. Remove, replace or reinforce as directed by the Architect if necessary to correct such conditions.
- B. If field conditions are determined to exist which would limit the guarantee of air delivery or system performance, due notice in writing shall be submitted to the Architect of such conditions prior to starting fabrication.
- C. Properly support and align ductwork. Ducts to be free of sag and bulge, Hang ductwork below concrete floors or roof deck with hangers set prior to pouring concrete, or from self drilling screw anchors. POWDER SET ANCHORS ARE NOT PERMITTED.
- D. Where it is necessary that ducts be divided due to pipes or other obstructions which must pass through these ducts, the Contractor shall, at locations as noted or directed, provide air-stream deflectors in the duct and the duct shall be increased in size to maintain equivalent area around deflectors. Such changes shall be in accord with standard SMACNA details and shall be shown on Contractor's As-Built Drawings.
- E. Interior of ductwork visible through registers, grilles, or diffusers shall be painted flat black.
- F. Do not route ductwork through transformer vaults and their electrical equipment spaces and enclosures.
- G. Construct all ductwork and accessories in accord with the latest indicated editions of applicable SMACNA construction standards. Sheet Metal and Air Conditioning Contractors' National Association.
- H. Streamline all ductwork to the full extent practical and equip with proper and adequate devices to assure proper balance and quiet draftless distribution of indicated air quantities.
- I. Protect all ductwork and system accessories from damage during construction until Architect's final acceptance of project.
- J. Prior to ductwork fabrication, verify if all ductwork as dimensioned and generally shown will satisfactorily fit allocated spaces. Take precautions to avoid space interferences with beams, columns, joists, pipes, lights, conduit, other ducts, equipment, etc. Notify Architect if any spatial conflicts exist and then obtain Architect's approval of necessary routing. Make any such necessary revisions which are minor at no additional cost.
- K. Carefully correlate all duct connections to air handling units and fans to provide proper connections, elbows and bends which minimize noise and pressure drop.

- L. Provide all curved elbows with radius ratios of not less than 1.5 unless otherwise shown or approved by Architect. Provide all mitred elbows with turning vanes.
- M. Properly suspend all ductwork so that no objectionable conditions result (such as vibration, sagging, etc.)
- N. Coordinate any and all dimensions at interfaces of dissimilar type of ductwork and at interfaces of ductwork with equipment so that proper overlaps, interfaces, etc., of insulation and continuity of vapor barriers are maintained.
- O. If necessary where ducts interface and have different types of insulation, provide transitions so that internal free-clear dimensions of duct remain unchanged.
- P. Install horizontal low pressure ductwork at a level which maximizes length of any vertical rectangular duct connections to rectangular diffuser necks; however, such vertical duct connections are not required to be over 24 inches in length.
- Q. Make connections from any low pressure ductwork to terminal units (fan terminal units, variable volume boxes, etc.) with appropriate lengths of flexible duct unless other type of connection is indicated.
- R. Install all flexible round duct without kinks or similar obstructions so that pressure drop is minimized. Cut and remove excess lengths as necessary.
- S. Install horizontal rigid ductwork as high as practical above suspended ceilings so that movable light fixtures may be relocated without interference to meet any future partition relocation requirements.

3.02 LOW PRESSURE SHEET METAL DUCTS

- A. If width or height of rectangular duct exceeds 12 inches, cross break or roll a cross bead in panels to increase stiffness; otherwise, use two gages heavier steel.
- B. Provide corner closures. Longitudinal seams and transverse joints shall be flat and smooth inside. Make slip joints in direction of air flow. See SMACNA manual for transition requirements.
- C. Fabricate offsets, turns and elbows with centerline radius equal to 1½ times diameter when possible. No mitred offsets will be allowed. Provide double thickness turning vanes to assist in smooth flow of air in square elbows or elbows with centerline radius less than duct width or diameter.

3.03 FLEXIBLE DUCTS

- A. Flexible ducts shall not be used unless specifically indicated on drawings.
- B. If flexible duct is indicated for use on this project, it must comply with the following requirements.
 - 1. The extent of the use of flexible ductwork shall be limited to that shown on the drawings.

2. Flexible duct installation shall be per SMACNA Flexible Duct Installation Standards and manufacturers latest printed instructions, whichever is stricter. In addition the, following shall apply:
 - a.. Flexible duct between rigid duct and diffusers shall be a MAXIMUM of 10 feet in length and shall be fully extended with a maximum equivalent of (2) 90° bends (no bend shall be made with centerline radius of less than one duct diameter.) No additional flexible duct shall be provided for future terminal device relocation unless otherwise specified.
 - b. Flexible duct shall be supported at ends and at each 90° bend. Maximum permissible sag is ½ inch per foot of spacing between supports.
 - c. Hanger or saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 1 inch wide. Narrower hanger material may be used in conjunction with a sheet metal saddle which meets the foregoing specifications. This saddle must be formed to cover one-half the circumference of the outside diameter of the flexible duct and must be rolled to fit neatly around the lower half of the duct's outer circumference.
 - d. Factory installed suspension systems integral to the flexible duct are an acceptable alternative hanging method when manufacturers recommended procedures are followed.
 - e. Hangers shall be adequately attached to the building structure (not pipe, conduit, etc.)
 - f. To prevent tearing of vapor barrier, do not support entire weight of flexible duct on any one hanger during installation. Avoid contact of flexible duct with sharp edges of hanger material. Damage to vapor barrier may be repaired with approved tape. If internal core is penetrated, replace flexible duct or treat as a connection.
3. Terminal devices connected by flexible duct shall be supported independently of the flexible duct.

C. Approved Manufacturer: FlexMaster

3.04 STAINLESS STEEL DUCT

- A. In addition to other requirements, stainless steel duct systems shall comply with the following:
 1. All joints and seams shall be made with continuous welds. Ductwork shall be liquid tight and gas tight.
 2. Hangers and supports in finished areas shall be of same material as ductwork.
 3. Joints in laboratory hood exhaust duct may be flanged and gasketed at the Contractor's option.
 4. Kitchen exhaust ductwork of stainless steel shall be installed in accordance with NFPA 96 Standard for removal of smoke and grease laden vapors from commercial cooking equipment.
 5. Install horizontal stainless steel kitchen exhaust ductwork with a minimum slope of 1" per foot.
 6. Provide access panels of suitable size at 3'-0" centers minimum and at each change of direction for cleaning purposes.
 7. Stainless steel shall be type 316, satin finish.
 8. Install grease duct and attachments per NFPA96 and all applicable codes.

3.05 MISCELLANEOUS DUCT SYSTEM COMPONENTS

- A. Spin-In Take-Off Fittings
 - 1. Install round duct branch takeoff fittings according to manufacturer's installation instruction. Additionally seal fitting to rectangular duct with a thin bead of mastic sealant.

3.06 HANGERS AND SUPPORTS

- A. General: Comply with latest applicable SMACNA construction standard. Where sprayed fireproofing occurs, install hangers before application of such treatment and withhold installation of ducts until after application.
- B. Supports: Vertical risers and other duct runs where tile method of support specified above is not applicable shall be supported by substantial angle brackets designed to meet field conditions and installed to allow for duct expansion.
- C. Fasteners: Secure hangers to steel beams or metal deck with beam clamps or drop through connections from the metal or concrete deck.

3.07 CHANGES IN SHAPE OR DIMENSION

- A. Where duct size or shape is changed to effect a change in area, the following shall apply:
 - 1. Where the area at the end of the transformation results in an increase in area over that at the beginning, the slope of the transformation shall not exceed 30° angle.
 - 2. Where the area at the end of the transformation results in a decrease in area from that at the beginning, the slope of the transformation shall not exceed 15°.
 - 3. The angle of transformation at connections to heating coils or shall not exceed thirty degrees from a line parallel to the air flow on the entering side of the equipment, nor fifteen degrees on the leaving side. The angle of approach may be increased to suit limited space conditions when the transformation is provided with vanes approved by the Architect.

3.08 CHANGES IN DIRECTION

- A. Changes in direction shall be basically as indicated on the drawings and the following shall apply:
 - 1. Supply duct turns of ninety degrees in low pressure duct shall be made with mitred elbows fitted with closely spaced turning vanes designed for maintaining a constant velocity through the elbow.
 - 2. Return and exhaust duct turns of ninety degrees in low pressure duct shall be made with mitred elbows, as specified hereinbefore, for supply ducts, unless radius elbows are indicated in which case they shall be vaned and constructed with a throat radius three quarters the duct width and a full radius heel.
 - 3. Tees in low pressure duct shall conform to the design requirements specified herein before for elbows.
 - 4. Branch take-offs in low pressure duct shall be made with extractors or splitter dampers, as indicated, in square take-offs.

3.09 IMPROPER MATERIALS OR CONFIGURATION

- A. If ductwork materials or ductwork configurations are installed which do not meet these specifications, Contractor shall remove such ductwork and replace with materials or

configurations which are acceptable. Any delay in job progress will be the responsibility of the Contractor.

3.10 OTHER REQUIREMENTS

- A. Insulated Duct: Where ducts will be insulated, make provision for neat insulation finish around damper operating quadrants, splitter adjusting clamps, access doors and similar operating devices. A metal collar equivalent in depth to insulation thickness and of suitable size to which insulation may be finished shall be mounted on duct.
- B. Control Devices: Properly install all control related devices which are part of the duct systems. See Section(s) describing control systems.

3.11 SEALING OF DUCTS

- A. Duct seal classes are as follows:
 - 1. Seal class "A": Seal all transverse joints, longitudinal, seams and duct wall penetrations. Use for PVC-4 (4" w.g.) and greater unless otherwise indicated.
 - 2. Seal class "B": Seal all transverse joints and longitudinal seams. Use for PVC-3 (3" w.g.) unless otherwise indicated.
 - 3. Seal class "C": Seal all transverse joints. Use for PVC-2 (2" w.g.) and lower unless otherwise indicated.
- B. Where sealing is required it shall mean the following:
 - 1. The use of adhesives, gaskets, tape systems or combinations thereof to close openings in the surface of the ductwork and field-erected plenums and casings through which air leakage would occur. All material shall meet or exceed UL181.
 - 2. The use of continuous welds.
 - 3. The prudent selection and application of sealing methods by fabricators and installers, giving due consideration to the designated pressure class, pressure mode (positive or negative), chemical compatibility of the closure system, potential movement of mating parts, workmanship, amount and type of handling; cleanliness of surfaces, product shelf life, curing time and manufacturer identified exposure limitations.
 - 4. That these provisions are applicable to duct connections to equipment and to apparatus but are not for equipment and apparatus.
 - 5. That where distinctions between seams and joints are made herein, a seam is defined as joining of two longitudinally (in the direction of air-flow) oriented edges of duct surface material occurring between two joints. Helical (spiral) lock seams are exempt from sealant requirements. All other duct surface connections made on the perimeter are deemed to be joints. Joints are inclusive of but not limited to girth joints; branch and sub-branch intersections; so called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum and casing abutments to building structures.
 - 6. That sealing requirements herein do not contain provisions to:
 - a. Resist chemical attack.
 - b. Be dielectrically isolated.
 - c. Be waterproof, weatherproof or ultraviolet ray resistant.
 - d. Withstand temperatures higher than 120°F or lower than 40°F.
 - e. Contain atomic radiation or serve in other safety-related construction.

- f. Be electrically grounded.
 - g. Maintain leakage integrity at pressures in excess of the duct classification herein.
 - h. Be underground below the water table.
 - i. Be submerged in liquid.
 - j. Withstand continuous vibration visible to the naked eye.
 - k. Be totally leak-free within an encapsulating vapor-barrier.
 - l. Create closure in portions of the building structure used as ducts, e.g., ceiling plenums, shafts, pressurized compartments.
 - 7. The requirements to seal apply to both positive pressure and negative pressure of operation.
 - 8. Externally insulated ducts located outside of buildings shall be sealed prior to being insulated as though they were inside. If metal surfaces of ducts located on the exterior of buildings are exposed to weather, they shall receive exterior duct sealant.

An exterior duct sealant is defined as a sealant that is marketed specifically as forming a positive air and water tight seal, bonding well to the metal involved, remaining flexible with metal movement and having a service temperature range of -30°F to 175°F. If exposed to direct sunlight it shall also be ultraviolet ray and ozone resistant or shall, after curing, be painted with a compatible coating that provides such resistance. The term sealant herein is not limited to materials of adhesive or mastic nature but is inclusive of tapes and combinations of open weave fabric strips and mastics.
- C. Materials and applications for sealing ducts.
- 1. General:
 - a. Complete product data on all materials used for sealing ducts must be submitted for approval prior to any duct fabrication.
 - b. All sealants must be specifically recommended by their manufacturer for the purpose of sealing ducts.
 - 2. Liquid sealant:
 - a. Use only for slip type joints where sealant is to fill small space between overlapping pieces of metal. Do not use where metal clearances exceed 1/32-inch.
 - b. Sealant must be specifically manufactured for the purpose of sealing ducts.
 - 3. Mastics:
 - a. Use in lieu of liquid sealant at Contractor's option.
 - b. Use as a fillet, in grooves and between flanges.
 - c. Do not use oil base caulking or glazing compounds.
 - 4. Gaskets:
 - a. Use soft elastomer butyl or extruded forms of sealants in flanged joints in addition to mastic.
 - 5. Tape:
 - a. Tape is not allowed on sheet metal ducts.
 - 6. Combination of mastic and embedded fabric:
 - a. Use mastic/mesh/mastic as a sealant where pressure/velocity classification equals and exceed P/V-C-3 and where any spaces between metal surfaces

at transverse joints or longitudinal seams or duct wall penetrations exceeds 1/16-inch.

- b. Apply glove coat of mastic, then embed a continuous or overlapping strip of not less than 4-inch wide 10 X 10 fiber glass cloth into the mastic, then apply a final glove coat of mastic over the glass cloth.
7. Surface preparation:
 - a. Surfaces to receive sealant should be adequately clean (free from oil, dust, dirt, rust, moisture, ice crystals and other substances that inhibit or prevent bonding.) Use solvent and/or apply a face primer if necessary to obtain adequately clean surface for adhesion.

3.12 LEAKAGE TESTING

A. General:

1. Test the following low pressure duct systems:
 - a. All ducts which are (1) under positive or negative pressure and (2) which are directly connected to air moving device (air handling unit, exhaust fan, supply fan or similar air moving equipment) and (3) which convey 1000-cfm or greater through their largest portion.
 - b. All ducts which are (1) under positive or negative pressure and (2) which are part of a supply, return, outside and/or exhaust air system and (3) which are equal to or greater than 25 feet in length and (4) which may or may not be directly connected to an air moving device.
2. Portions of duct to be tested shall consist of all portions from the largest cross sectional area to the air distribution device connection or to the smallest inlet or outlet point, whichever is applicable.

B. Test Procedure:

1. Test at time of duct installation and prior to installation of any field applied insulation and prior to any concealment in chases or similar enclosures.
2. Test for audible leaks as follows:
 - a. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
 - b. Start the blower with its control damper closed (some small blowers popularly used for testing ducts may damage the duct because they can develop pressures up to 25 inches (w.g.)
 - c. Gradually open the inlet damper until the duct pressure reaches 50% in excess of designed duct operating pressure.
 - d. Survey all joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealing has been repaired if and where necessary.
3. Correct any duct leaks which are detected either audibly or by touch regardless of whether leakage through duct system is less than allowable test leakage.
 - a. The maximum permissible percent of leakage shall be confined to 2% of the total CFM airflow of the respective fan/duct system.
 - b. Results of the leakage shall be reviewed by Architect/Engineer prior to the installation of the insulation.

END OF SECTION

**SECTION 15860
DUCT ACCESSORIES**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION OF WORK

- A. Extent of duct accessories work is indicated on drawings and in schedules, and by requirements of this section.
- B. Types of duct accessories required for project include the following:
 - 1. Dampers
 - 2. Low pressure manual dampers
 - 3. Control dampers
 - 4. Counterbalanced relief dampers
 - 5. Turning vanes
 - 6. Duct hardware
 - 7. Duct access doors
 - 8. Flexible connections
 - 9. Duct access door/pressure relief door

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of duct accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. SMACNA Compliance: Comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) HVAC duct construction standards.
- C. Industry Standards: Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of duct accessories, except as otherwise indicated.
- D. UL Compliance: Construct, test, and label fire dampers and smoke/fire dampers in accordance with Underwriters Laboratories (UL) Standard 555 "Fire Dampers and Ceiling Dampers".
- E. NFPA Compliance: Comply with applicable provisions of ANSI/NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of duct accessories.

1.04 SUBMITTAL

- A. Product Data: Submit manufacturer's data for each type of duct accessory, including dimensions, capacities, and materials of construction; and installation instructions.

- B. Shop Drawings: Submit assembly-type shop drawings for each type of duct assembly showing interfacing requirements with ductwork, and method of fastening or support.
- C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory, include this data in Maintenance Manual.

PART 2 - PRODUCTS

2.01 DAMPERS

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with SMACNA "Low Pressure Duct Standards".
- B. Control Dampers: Refer to Division-15000 section "Temperature Control Systems" for control dampers; not work of this section.
- C. Counterbalanced Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 16 gauge aluminum, provide 1/2" diameter ball bearings, 1/2" diameter steel axis spaced on 9" centers. Construct frame of 2" x 1/2" x 1/8" steel channel for face areas 25 square feet and under; 4" x 1-1/4" x 16 gauge channel for face areas over 25 square feet. Provide galvanized steel finish on frame with aluminum touch-up.
- D. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering dampers which may be incorporated in the work include, but are not limited to, the following:
 - 1. Greenheck
 - 2. Ruskin Mfg. Co.
 - 3. Approved Equal

2.02 FIRE AND SMOKE DAMPERS

- A. Fabricated Fire Dampers: Provide dampers constructed in accordance with SMACNA "Fire Damper and Heat Stop Guide".
- B. Fire Dampers: Provide fire dampers, of types and sizes indicated. Construct casings of 22 gauge galvanized steel with bonded red acrylic enamel finish. Provide fusible link rated at 160-166° F (71-74° C) unless otherwise indicated. Provide damper with positive lock in closed position, and with the following additional features:
 - 1. Damper Blade Assembly: Single-blade type (ducts less than 20" deep).
 - 2. Damper Blade Assembly: Multi-blade type.
 - 3. Blade Material: Steel, match casing.
- C. Motor Driven Smoke Dampers: Provide smoke damper, resettable type linkage of sizes indicated, designed and constructed in accordance with NFPA-9A, motor operated, frame constructed of 16 gauge galvanized steel with provisions for securing to building and attaching to ducts, electric motor operator, casing to have a bonded red acrylic enamel finish, low leakage with friction free metal seals, 32" long wire leads for connecting to smoke detector, and the following additional features:
 - 1. Damper Blade Assembly: Single-blade type (ducts less than 10" deep).
 - 2. Damper Blade Assembly: Multi-blade type.
 - 3. Blade Material: Steel, matching casing.

- D. Motor-Driven Fire/Smoke Dampers: Provide motor-driven fire/smoke dampers in types and sizes indicated, with casing constructed of 16 gauge galvanized steel with bonded red acrylic enamel finish, fusible link 160-165° F (71-74° C), unless otherwise indicated, and curtain type galvanized steel interlocking blades, with electric motor equipped with instant closure clutch, motor mounting bracket, and 32" long wire leads for connecting to smoke detector, and with the following construction feature:
1. Unit Assembly: Motor mounted outside air stream.
- E. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering fire and smoke dampers which may be incorporated in the work include, but are not limited to, the following:
1. Air Balance, Inc.
 2. Airstream Products Div., Penn Ventilator Co., Inc.
 3. American Warming & Ventilating, Inc.
 4. Arrow Louver and Damper Corp.
 5. Greenheck
 6. Louvers & Dampers
 7. Phillips-Aire
 8. Ruskin Mfg. Co.

2.03 TURNING VANES

- A. Fabricated Turning Vanes: Provide fabricated turning vanes and vane runners constructed in accordance with SMACNA "Low Pressure Duct Standards".
- B. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2" wide curved blades set at 1-1/2" o.c., supported with bars perpendicular to blades set at 2" o.c., and set into side strips suitable for mounting in ductwork, per SMACNA Standards for Low Pressure Duct.
- C. Acoustic Turning Vanes: Provide acoustic turning vanes constructed of airfoil shaped aluminum extrusions with perforated faces and fiberglass fill.
- D. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering turning vanes which may be incorporated in the work include, but are not limited to, the following:
1. Air Filter Corp.
 2. Anemostat Products Div., Dynamics Corp. of America
 3. Barber Colman Co.
 4. Duro-Dyne Corp.
 5. Environmental Elements Corp., Subs. Koppers Co., Inc.
 6. Register & Grille Mfg. Co.
 7. Tuttle & Bailey Div. of Interpace Corp.

2.04 DUCT HARDWARE

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes consisting of slot and cover, for instrument tests.
 2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft, and end bearing plate on other end for damper lengths over 12". Provide

extended quadrant locks and end extended bearing plates for externally insulated ductwork.

3. Concealed Damper Regulators: For dampers located above inaccessible plaster or gypsum board ceilings, provide Young Regulator Co. Model No. 301 CDS concealed regulators with cover plates. Units shall be flush with finished surface. Key shall operate damper rod. Lock nut and spring washer shall hold damper in fixed position.
- B. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering duct hardware which may be incorporated in the work include, but are not limited to, the following:
 1. Ventfabrics, Inc.
 2. Young Regulator Co.
 3. Approved Equal

2.05 DUCT ACCESS DOORS

- A. General: Provide, where indicated, duct access doors of size indicated.
- B. Construction: Construct of same or greater gauge as ductwork served; provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with 1-handle type latch for doors 12" high and smaller, 2-handle type latches for larger doors.
- C. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering duct access doors which may be incorporated in the work include, but are not limited to, the following:
 1. Aeronca Inc., Buensod/Agitair Div.
 2. Air Balance Inc.
 3. Duro Dyne Corp.
 4. Register & Grille Mfg. Co., Inc.
 5. Ruskin Mfg. Co.
 6. Ventfabrics, Inc.
 7. Zurn Industries, Inc., Air Systems Div.

2.06 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

2.07 DUCT ACCESS DOOR/PRESSURE RELIEF DOOR

- A. General: Provide a duct access door/pressure relief door in all high pressure duct immediately downstream of all fire dampers, smoke dampers and fire/smoke dampers.
- B. Construction: Factory-fabricated access section, 20 gauge galvanized sheet metal housing welded to round galvanized duct section, gasketed transparent shatterproof cover (inside mounted), pressure sensitive release for manual or emergency vacuum release, pressure sealed, cover handle and cover retaining chain. Provide pre-insulated if duct is to be insulated.

- C. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering duct access/ pressure relief doors which may be incorporated in the work include, but are not limited to, the following:
1. United McGill Corp., Type AR-W Access Section
 2. Or approved equal.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which duct accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular elbows in supply return and exhaust air systems, and elsewhere as indicated.
- C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- D. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work,
- E. Field Quality Control: Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories as required to obtain proper operation and leak-roof performance.

END OF SECTION

SECTION 15864
SMOKE AND FIRE DAMPERS

PART 1 GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of all smoke and fire dampers as specified herein.

1.03 SUBMITTALS

- A. Submit manufacturer's data and outline drawings for review before any work is commenced.
- B. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions" and other similar provisions.
- C. Take adequate precautions to insure that installed dampers/operators are protected from damage during construction.

PART 2 PRODUCTS**2.01 GENERAL**

- A. Fire dampers shall comply with Underwriters Laboratories (UL) Standard 555 and bear the UL test label.
- B. Smoke dampers shall comply with Underwriters Laboratories (UL) Standard 555(S) and bear the UL test label.
- C. The sheet metal contractor, in conjunction with the metal stud contractor and drywall contractor, shall fabricate a mock-up of a fire/smoke damper installation in a one-hour smoke wall. The mock-up shall contain all required framing, retaining angles, sleeves, caulking, drywall and other appurtenances as shown on the details and/or tile manufacturers installation instructions. After fabrication, the mock-up shall be approved by the Engineer. The mock-up shall remain on the project premises to be used for reference and training purposes.

2.02 FIRE DAMPERS

- A. Fire damper(s) shall be constructed with casings of 11 gauge galvanized steel with bonded red acrylic enamel finish interlocking type damper blade assembly, and fusible link rated at 160-165OF unless noted otherwise on the drawings. Provide factory furnished duct installation sleeve. Sleeve shall be minimum 16 gauge for dampers up to 36" wide X 24" high and 14 gauge for sizes exceeding 36 X 24. Dampers shall be style "B", 100% full duct opening, and bear 1-1/2 hour UL label.
- B. Approved Manufacturers are:
 - 1. Ruskin Mfg. Co.
 - 2. Nailor Hart

3. Greenheck.

2.03 SMOKE DAMPERS

- A. Provide multi-blade type smoke damper, resettable type linkage of sizes indicated, pneumatic operated, frame constructed of 10 gauge galvanized steel with provisions for securing to building and attaching to ducts, electric damper activator (see control drawings and specifications,) casing to have a bonded red acrylic enamel finish, low leakage with friction free metal seals and matching factory furnished installation sleeve.
- B. Operator motor shall be mounted out of air stream.
- C. Motor operators shall be equal to Ruskin MA220 (electric).
- D. Approved Manufacturers are:
 1. Nailor Hart
 2. Ruskin
 3. Louvers and Dampers
 4. American Warming and Ventilating
 5. Prefco Products
 6. Air Balance, Inc.

2.04 COMBINATION FIRE/SMOKE DAMPERS

- A. Provide multi-blade type motor-driven fire/smoke dampers in types and sizes indicated, with casing constructed of 10 gauge galvanized steel with bonded red acrylic enamel finish, fusible link 160-165°F (71-740C), unless otherwise indicated, with pneumatic motor, motor mounting bracket and matching factory furnished installation sleeve.
- B. Operator motor shall be mounted out of air stream.
- C. Motor operator shall be equal to Ruskin MA220 (electric).
- C. Motor operator shall be equal to Johnson D3153 (pneumatic).
- D. Approved Manufacturers are:
 1. Nailor Hart
 2. Ruskin
 3. Louvers and Dampers
 4. American Warming and Ventilating
 5. Prefco Products
 6. Air Balance, Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide access doors to facilitate relinking of fire dampers.
- B. See installation details on plans.
- C. Adhere strictly to damper manufacturer's instruction.

END OF SECTION

SECTION 15872**LOUVERS****PART I GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of complete louver assemblies as specified herein. Provide as indicated on Drawings and in Specifications.

1.03 RELATION TO OTHER WORK

- A. Refer to the section entitled "General Mechanical Provisions".

1.04 CERTIFICATION

- A. All performance shall be certified by AMCA and bear the AMCA Certified Ratings Seal for Air Performance and Water Penetration in accord with AMCA Standard 500.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS**

- A. Stationary type; extruded aluminum construction.
- B. All components factory assembled by the louver, manufacturer including heads, jambs, sills, blades and mullions. Louver sizes too large for shipping shall be assembled at the site from factory assembled louver sections to provide the overall sizes required.
- C. Frame:
 - 1. 4" minimum depth.
 - 2. Suitable for mounting in the type of wall where indicated. Coordinate with wall construction indicated on architectural drawings.
 - 3. Extruded aluminum of 0.125" minimum thickness.
 - 4. Provided with caulking slots.
 - 5. Drainable and meet local Hurricane wind resistance.
- D. Blades:
 - 1. Drainable type with drain gutter in each blade and down spouts in jambs and mullions.
 - 2. Extruded aluminum of 0.125" minimum thickness.
 - 3. Approximately 37½° blade angle.
 - 4. Blades on approximately 4½" centers.
- E. Finish: Mill, or as otherwise indicated or schedules.

- F. Operating characteristics
 - 1. High free area.
 - 2. Low water penetration.
 - 3. Free area based on air velocity of not greater than 400-fpm.
 - 4. Air flow pressure drop in intake mode or exhaust mode of not greater than 0.025" w.g.s.p.
- G. Design shall limit span between visible mullions to 10' and shall incorporate such other structural supports required to withstand a wind load of 20 lbs. per sq. ft.
- H. Size as scheduled or shown on Drawings or as required to comply with the above operating characteristic constraints.
- I. Security fasteners required on all outside door transfer grilles.

2.02 ACCESSORIES

- A. Bird screen: aluminum, ¾" mesh.
- B. Frame flange, 1½" nominal width.
- C. Extended sill.
- D. Security screws.

2.03 APPROVED MANUFACTURERS

- A. Approved manufacturers include:
 - 1. Greenheck
 - 2. Ruskin
 - 3. American Warming & Ventilating
 - 4. Carnes
 - 5. Krueger
 - 6. Louver & Dampers, Inc.
 - 7. Metal Industries
 - 8. Approved equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Install in accord with manufacturers recommendations and in accord with applicable portions of current SMACNA guidelines.
- B. Installation shall be watertight between complete circumference of frame and wall.
- C. Coordinate complete installation with other work related to structure, wall construction, ductwork (if any) and other such interfaces.
- D. All louvers shall be hurricane proof.

END OF SECTION

SECTION 15915
PROGRAMMABLE THERMOSTAT

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Related work in other sections of the specifications:
 - 1. Section 15010 – General Provisions for Mechanical Work.
 - 2. Section 16010 – General Provisions for Electrical Work

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of all programmable thermostats as specified herein.

1.03 QUALITY ASSURANCE

- A. Responsibility: The supplier shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him.
- B. Component Testing: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. Each and every component shall be individually tested by the manufacturer prior to shipment.
- C. Tools, Testing and Calibration Equipment: Provide all tools, testing and calibration equipment necessary to ensure reliability and accuracy of the system.

1.04 REFERENCE STANDARDS

- A. The latest edition of the following standards and codes in effect and amended as of date of Supplier's Proposal, and any subsections thereof as applicable, shall govern design and selection of equipment and material supplied:
 - 1. ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Engineers.
 - 2. UL 916 – Underwriters Laboratories Standard for Energy Management Equipment.
 - 3. NEC – National Electrical Code.
- B. City, county, state and federal regulations and codes in effect as of date of purchase.
- C. Except as otherwise indicated, vendor shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

1.05 SUBMITTALS

- A. Drawings:
 - 1. The Supplier shall submit control drawings, installation and operation instruction and a recommended spare parts list.

2. Drawings shall be standard sizes (24 inches x 36 inches) or reduced size 11 inches x 17 inches.
- B. System documentation by the Vendor shall include the following as a minimum:
 1. System configuration diagrams in simplified block format.
 2. Controls electrical interlock drawings showing all system internal and external connection points, terminal block layouts and terminal identification.
 3. Manufacturer's instructions and drawings for installation, maintenance and operation of all purchased items.

1.06 WARRANTY

- A. Warranty shall cover all costs for parts, labor, associated travel, any software sequence modifications and expenses for a period of one year from completion of system demonstration and final acceptance by Owner.
- B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the Vendor.
- C. This warranty shall apply equally to both hardware and software.

1.07 MANUFACTURER

- A. Approved manufacturers:
 1. Alerton Technologies, Inc. (Control Systems Specialists, Inc., Tampa, Florida).
 2. Carrier
 3. Trane
 4. York

PART 2- MATERIALS

2.01 SYSTEM DESCRIPTION

- A. Controls shall be a low voltage, electric solid state microcomputer based room thermostat located as indicated. Room thermostat shall incorporate:
 1. Preferential rate control to minimize overshoot deviation from set point.
 2. Instant override of setpoint for continuous or timed period from one hour to 31 days.
 3. Short cycle protection.
 4. Programming based on weekdays, Saturday and Sunday.
 5. Switch selection features including digital display, 24 hour clock, remote sensor, fan on-auto.
 6. Humidity controls.
- B. Room thermostat display shall include:
 1. Time of day.
 2. Actual room temperature.
 3. Programmed temperature.
 4. Programmed time.
 5. Duration of timed override.
 6. Day of week.
 7. System Model Indication: Cooling, auto, off, fan auto, fan on.

PART 3 - EXECUTION**3.01 GENERAL**

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this section may properly commence.
- B. Notify the Owners Representative in writing of conditions detrimental to the proper and timely completion of the work.
- C. Do not begin work until all unsatisfactory conditions are resolved.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to insure a complete operating system in accordance with the sequences of operation and point schedules.

3.03 LOCATION AND INSTALLATION OF COMPONENTS

- A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units. Obtain Owner Representative's approval on locations prior to installation.
- B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration and high temperatures.
- C. Identify all equipment and panels. Provide permanently mounted tags to all panels.
- D. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections; sized to suit pipe diameter without restricting flow.

3.06 DEMONSTRATION

- A. Demonstrate complete and operating system to Owner's Representative.
- B. Provide certificate stating that control system has been tested and adjusted for proper operation.

3.07 SEQUENCE OF OPERATION (See Equipment Schedules)

END OF SECTION

**SECTION 15990
TEST AND BALANCE**

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

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

1.02 DESCRIPTION OF WORK

- A. Extent of mechanical work is indicated drawings and by requirements of this section.

1.03 REFERENCE STANDARDS

- A Associated Air Balance Council (AABC): National Standards for Total System Balance

1.04 QUALITY ASSURANCE

- A. Installer: Independent (not associated with the Contractor or any installers) Company or individual specializing in testing, adjusting and balancing of mechanical systems and having 5 years experience. An AABC certified company is a minimum requirement and only AABC Total System Balance procedures and AABC forms may be used.

1.05 SUBMITTALS

- A. Mechanical Submittal Package Number 1: List of Installers and Manufacturers.
1. Combine the requirements of this Article with the requirements of other Mechanical Sections into one complete submittal package.
 2. Provide a letter of certification indicating installer's length of experience in testing, adjusting and balancing of mechanical systems.
- B. Mechanical Submittal Package Number 10: Final Testing, Adjusting and Balancing.
1. Submit final testing, adjusting and balancing package to Architect for review after successful completion of testing, adjusting and balancing work. Indicate that each device is balanced to specified flow rates. Do not forward final report to the Architect until all systems are operating as designed.
 2. Submit report to Architect prior to Substantial Completion review of the installation (this report is prerequisite before Substantial Completion is accepted).

PART 2 – PRODUCTS

Not Used

PART 3 - EXECUTION**3.01 GENERAL**

- A. Provide testing, adjusting and balancing of HVAC and Plumbing systems by a test and balancing agency using AABC procedures

3.02 TESTING AND BALANCING

- A. Coordination: provide coordination between the Contractor, various Installers (such as HVAC, Plumbing, Controls and Electrical) and the Test and Balance Agency, as identified in the AABC Total System Balance Manual, Chapter 16. Coordination includes start-up and operation of the systems by the Contractor (as noted in Chapter 16). Also, drive changes and system component changes required by the Total System Balance is to be provided by the Contractor as part of Basic Work (as noted in Chapter 16). Provide coordination meetings and reviews for each System before and during construction, as required, for a proper Total System Balance.
- B. Test, Adjust, Balance and record Air, HVAC meter in/out and water temperature (using AABC forms only) each of the following:
1. RM
 2. Electric Radiant Panel
 3. GWH
 4. AHU
 5. PTAC
 6. EF
 7. SF
 8. KVS
 9. AO
 10. AI
 11. VAV Box
 12. Manual Balancing Damper
 13. Automatic Damper
 14. Pump
 15. Combination Flow/Balancing Valve
 16. Coil
 17. FF
 18. CU
 19. DH
 20. EUH
 21. WAC
 22. Thermostat
 23. Temperature Sensor
- C. Test and operate VAV and variable flow system components from 100% to 0%. Coordinate with the Contractor, Test and Balance Agency, and Controls Installer for VAV box software minimum/maximum stops. Provide subsequent testing of VAV systems (not components) using the specified ranges. Do not damage ducts, fans, pumps or accessories.
- D. Provide final hydronic adjustment (including trimming of pump impellers and re-adjustment of valves) after preliminary balancing. Include pump adjustment to field conditions as part of Basic Work.
- E. Electrical: Include record of each motor voltage, operating current, and overload protection.
- F. Diagrams: Provide scaled diagram to locate balancing dampers and other items not clearly identified by a room number.
- G. Combustion Test: Provide special combustion testing of GWH, as described in AABC.

- H. Owner Verification: After the Total System Balance has been performed and the final Test and Balance Report has been prepared, the Owner will independently verify the report using AABC procedures. As part of Basic Work, make all required modifications to systems (including drive changes and other system component changes) and to the final Test and Balance Report (TYPED not handwritten) for the Contractor's revised final Test and Balance Report to fully agree with the Owner's independent Verification Report. As part of Basic Work make on set of Contract Documents, equipment information and system data available for the Owner's verification Test and Balance Agency to use. Reinspection costs (after the Verification Report has been issued and items are still beyond AABC Total System Balance limits) for the Owner's verification Test and Balance Agency will be paid by the Contractor, as a Change Order to the Contract. The Owner's verification Test and Balance Agency will use procedures and perform coordination with the Contractor's Test and Balance Agency, as identified in AABC Total System Balance Manual. Measurements and/or a report alone are not acceptable; unresolved items must be remediated with the Contractor.
1. Temperature measurements: If required, perform special room temperature measurements and coordinate with the Contractor and Controls installer for controls equipment (including thermistors) calibration. Recalibrate until room temperature variation does not exceed 2 degrees from the median temperature during a one-hour period. Submit room temperature in each thermally controlled space (room thermistor or room thermostat). Indicate outside air temperature during the tests.

END OF SECTION

**SECTION 15992
STARTUP & CERTIFICATION OF AIR, WATER & CONTROL SYSTEMS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Preparation of startup certification report.
- B. Verification, measurement and setting of all water and pump flows.
- C. Verification, measurement and balancing of all air flow devices.
- D. Verification of proper performance of all controls.
- E. Sound measurement of equipment during operation, where specified.
- F. Verification of vibration limits where specified.
- G. Submittal of Contractor's certification forms.

1.02 RELATED SECTIONS

- A. Division 1 - General Requirements
- B. Division 15 - Mechanical (all applicable sections).
- C. Division 16 - Electrical (all applicable sections).

1.03 GENERAL REQUIREMENTS

- A. Certification and Substantial Completion Inspection Report
 - 1. Work Required: Submit signed certification report. Facilitate and cooperate with Owner's verification of certification reports. Adjust and correct systems as required based upon Owner's verification of certification report and submit revised report reflecting system adjustments, corrections and compliance with required performance. Operate all system components during Owner's substantial completion inspection. **Substantial completion shall not occur until 30 days after approval of certification.**
 - 2. The Project Consultant is to make the final determination that all systems have been balanced to produce the desired results. Additional work requested will be at no additional expense to the Owner and may be requested any time until final acceptance of the building by written notice to the Contractor by the Owner or Project Consultant.
 - 3. The Contractor is to be financially responsible for direct time and material expenses incurred by the Owner after initial Test and Balance if total flows of all air and water systems have not been adjusted to within plus 10 percent or minus 5 percent of design as certified. It is the Contractor's responsibility to correct or identify all problems with systems prior to final startup. Document design or equipment problems which prevent proper system performance to the Project Consultant 30 days prior to final startup and certification.

1.04 VERIFICATION BY OWNER

- A. Upon receipt of the "Certification Report" signed by the Contractor, the Owner shall engage an independent Test & Balance Consultant to verify the information contained therein. The Contractor will be present during the verification of the data contained in the Certification Report to provide proper operation and sequencing of the system.
- B. The Owner's Test and Balance Consultant will conduct tests as required to verify up to, but not necessarily, 100 percent of the data contained in the Contractor's certification report. The Owner's Test and Balance Consultant may perform additional testing and balancing to further improve system efficiency and performance. Any subsequent balancing and adjusting of systems by the Owner's Test and Balance Consultant will not mitigate the Contractor's ultimate responsibility for system performance or systems and equipment warranties as defined by the Contractor's contract with the School Board of Broward County.
- C. The Owner will notify the Contractor of system construction, performance and operational deficiencies which will require immediate correction by the Contractor.

1.05 DEFINITIONS

- A. Adjust: To regulate the specified fluid rate and air patterns at the terminal equipment (e.g. reduce fan speed, throttling).
- B. Balance: To proportion flows within the distribution system (submains, branches and terminals) under provisions with specified design quantities.
- C. Building Project: The general construction project under which the mechanical systems requiring these Testing and Balancing services were installed.
- D. Certification: A legal document consisting of a letter from the Contractor.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report Forms: Test Data Sheets arranged for collection of test data in logical order for submission and review. Data should also form the permanent record which shall be used as the basis for any future testing, adjusting and balancing required.
- G. Startup: Testing and balancing as required to place all total air and water systems and controls in operation and operating within plus 10 percent or minus 5 percent of design and verification of control operation within manufacturers tolerances.

1.06 SUBMITTALS

- A. Submit startup and certification data with certification letter (see end of section for letter format).
- B. Identify Project, Project Phase, Project Location and subcontractor as applicable.
- C. Startup Certification Report.
 - 1. Provide five copies, each bound in separate soft cover, letter size, bound complete with index page and indexing tables with cover identification at front and at binding edge.

2. Include signed startup certification letter from Contractor, from the manufacturer of each major piece of refrigeration or heating equipment, water treatment supplier and from temperature control manufacturer.
3. Include all complete report forms, signed by Contractor.
4. Identify items not conforming to the Contract Documents and any mal-operation or design deficiency, previously reported and unresolved.
5. Provide startup certification that all systems and components meet or exceed required operational and performance except for deficiencies noted as required above.
6. Provide 8 inch x 11 inch schematics accurately recording locations of all numbered, measured and adjusted system components with room numbers.
7. Certify that all access panels or removable ceilings have been installed for proper access for test and balance and maintenance of equipment, balancing valves, dampers, motors and controls and that they have been labeled.

1.07 REPORT FORMS

- A. Submit reports on Owner provided standard forms including, but not limited, to the following information:
 1. Title Page:
 - a. Contractor Name, Contact Person.
 - b. Contractor Address.
 - c. Contractor Telephone Number.
 - d. Project Name.
 - e. Project Address.
 - f. Project Architect.
 - g. Project Engineer.
 2. Report Forms Supplied by the Owner:
 - a. Certification Letter.
 - b. Air Moving Equipment Test Sheet.
 - c. Fan and Motor Pulley.
 - d. Static Pressure.
 - e. Return Air/Outside Air Data.
 - f. Duct Traverse Readings.
 - g. Duct Traverse Zone Totals.
 - h. Air Distribution Test Sheet.
 - i. Exhaust Fan Data Sheet.
 - j. Electric Duct Heater.
 - k. Terminal Units.
 - l. Duct Leak Test.
 - m. Chillers.
 - n. Cooling Tower.
 - o. Pump Data Sheet.
 - p. Air Cooled Condenser.
 - q. Flow Measuring Station.
 - r. Cooling Coil Data.
 - s. Heating Coil Data.
 - t. Sound Level Report.
 - u. Octave Band Chart.
 - v. Vibration Test Data (Air Handling Unit).
 - w. Vibration Test Data (Centrifugal Fan).

- x. Vibration Test Data (In-Line Fan).
- y. Vibration Test Data (Utility Fan).
- z. Vibration Test Data (Vaneaxial Fan).
- aa. Vibration Test Data (End Suction Pump).
- bb. Vibration Test Data (Horizontal Split Case Pump).
- cc. Smoke Detector Test Sheet.

PART 2 - PRODUCTS – Not Used

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before presenting certification to Owner, verify that systems are complete and operable. Ensure the following:
 - 1. Equipment is operable and in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean of debris, properly installed and free of bypass.
 - 5. Duct systems are clean of debris.
 - 6. All rotating equipment has proper alignment, clearances, noise and vibration levels. All are rotating in correct direction.
 - a. All belts are installed with proper quantity, strength and size and are set for proper tension.
 - b. Belt size is such that all adjustable motor mounts are in midposition at final balance point.
 - c. Sheaves are aligned...from motor shaft to drive shaft...within 1/16 inch of true centers.
 - d. Motor sheaves are installed as close to motor as feasible for installation.
 - 7. Fire and volume dampers are in place and open.
 - 8. Coil fins have been cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage has been minimized.
 - 12. Hydronic systems have been flushed, filled and vented.
 - 13. Proper strainer baskets are in place and clean.
 - 14. Service valves are open and balance valves are set.
 - 15. All hydronic systems are free of air.
 - 16. All motor amperages at final flow are at or below nameplate rating of full load at applied voltage.

3.02 AIR SYSTEM PROCEDURES

- A. Adjustments: Adjust all air handling systems to provide the required design air quantity to or through each component to plus 10 or minus 5 percent.
 - 1. Total air streams have been set with fan speed only. All total main stream dampers shall be wide open at final condition; i.e. inlet vane dampers, smoke/fire dampers,

main duct volume damper and at least one branch volume damper shall be wide open.

2. Whenever VAV systems are provided, final air pressure shall be no more than 0.3 inch w.g. in excess of that required to drive system at full flow. With system in simulated full flow condition, IVVDD's shall be closed back until total flow rate just starts to drop below design levels. The pressure at that point shall be increased by 0.3 inch w.g. by fan speed adjustment only after full flow has been established for each component of each system.
- B. Balance: Branch dampers shall be used to balance air quantities only. Use of opposed blade dampers at diffusers is prohibited. Diffuser shall be 100 percent open.
- C. Final measurements of air quantity will be taken after air terminals have been adjusted to provide optimum diffusion of air patterns.
- D. Fan Adjustment: Vary total air system quantities only by fan speed adjustment or pulley replacement as required.
- E. Air Measurement: Utilize pitot tube traverse to measure duct air flow systems over 2000 CFM as conditions permit, unless otherwise specified.
- F. For duct design air quantity less than 2000 CFM, air quantity may be determined by measurements at air terminals served.
- G. Test Holes: Locate in straight duct, as far downstream as possible from elbows, bends, takeoffs and other turbulence generating devices to optimize reliability of flow measurements. Seal holes with plastic plugs. No tape seals allowed. Pitot traverse holes in insulated duct in non-conditioned space shall have centlok collars.
- H. Return Air Plenum: A room being used as a return air plenum shall have a static pressure in excess of -0.25 inch w.g.
- I. Leakage across closed bypass dampers shall not exceed 5 percent of total air stream.
- J. Smoke detectors are to be certified by the use of the pressure differential method.

3.03 WATER SYSTEM PROCEDURES

- A. Heat Transfer Equipment: Adjust as required to provide design flow (plus or minus 10 percent for coils, plus 10 percent or minus 5 percent for major equipment).
- B. Three-Way Valves: Adjust flow through bypass circuits at three-way, two position valves to balance flow through the supply circuit.
- C. Adjust distribution by using balancing devices (cocks, valves, fittings). Use of service valves not allowed. Pump discharge shall be wide open at final flow.
- D. All cooling tower basins shall be balanced to have identical water levels at full flow. Nozzle size and quantity shall be such that actual water level in basins is at manufacturer's specification with one balancing valve open.
- E. Trim pump impellers as necessary to deliver design flow GPM.

- F. All steel piping systems shall have had proper startup chemicals, cleaners, neutralizers and appropriate flushing before final filling of system and operation of equipment. Water treatment shall be at controlled condition within one week of start of operation.
- G. Adjust system pressure so that static pressure at uppermost section shall be minimum of 15 PSIG.

3.04 OWNER'S ACCEPTANCE AT STARTUP CERTIFICATION

- A. Owner will verify 100 percent startup certification forms submitted by the Contractor. 100 percent of all data submitted shall be within plus 10 percent or minus 5 percent of that recorded in the startup certification report or certification will be automatically rejected. In the event the certification is rejected, readjust and test all systems, record new data and submit new certified startup certification prior to the Owner's Substantial Completion Inspection.

3.05 VIBRATION AND NOISE

- A. Equipment vibrating or producing noise in excess of manufacturer's specifications or equipment producing noise in excess of specified noise levels will be corrected by the Contractor prior to Owner's acceptance of certification.

END OF SECTION

**SECTION 15995
FIRE PROTECTION**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION OF WORK

- A. This section includes the providing and installing of all materials, equipment and incidentals necessary and/or required for a complete installation of an Automatic Fire Sprinkler System as specified herein.
- B. The extent of the fire protection work required shall be as follows: It shall be the responsibility of the awarded contractor to provide system layout documents, shop drawings, hydraulic calculations, and other drawings, cut sheets, and submittal data required to complete the package as required by the building department and the AHJ (Authority Having Jurisdiction). These items (and any other requested supplementary data) signed and sealed by the engineer shall be submitted to the architect for a peer review prior to the submission to the aforementioned authorities. The peer review shall be by the registered professional engineer of the architect's choice. These reviewed and approved documents shall be submitted by the contractor to the appropriate authorities for permits and inspections as required. The person signing and sealing these documents shall be a Florida registered professional engineer in good standing with the board, compliant with all current requirements to practice engineering in the state of Florida. The contractor shall provide and install the system described in the architect approved drawings which shall also be in compliance with this specification.
- C. Fire protection work shall include, but not limited to the following:
1. A backflow prevention device of the type approved by Public Utility. Sized by hydraulic calculation of system. General contractor shall provide concrete pad at grade for backflow prevention device. The pressure drop across this device shall not exceed 8 PSI at the design sprinkler flow or 12 PSI at 150% of the rated fire pump capacity (if required).
 2. Excavation, trenching, backfill compaction and other associated materials and processes associated with proper burial of fire protection system piping.
 3. Connection to city water main and associated underground piping to connect backflow preventer and system risers. As verified by hydraulic calculation.
 4. A fire pump (if required) that shall be U.L. Listed and F.M. approved and installed in accordance with NFPA 20. Pump system shall include but not be limited to: pump, pump controller, jockey pump, jockey pump controller, valves, check valves, test manifold, gauges, interface for pump alarms and alarm system. Where a diesel fire pump is employed at minimum the contractor shall additionally supply a diesel tank, fuel transfer system, complete critical grade exhaust system, and complete engine / exhaust insulation system or kit. The pump shall be sized by hydraulic calculation. The controller is expected to be a full function (such as master EC series or DCM series).
 5. A system riser or risers as described in the NFPA chapter 13 including pressure gauges, test and drain valve, check valve, and control valve(s), drain riser. As sized by hydraulic calculation.

6. A standpipe system executed and installed in accordance with the provisions of NFPA 14 (class 1, wet, automatic design) with 2 ½" hose connections provided with reducer couplings (1 ½") and caps. Reducers and caps shall be chained or otherwise permanently secured to the standpipe.
7. Fire department connections shall be provided for charging standpipes and the automatic sprinkler system.
8. Inspectors test stations and system drains as required to complete the system.
9. Associated main, cross main, branch, and other piping and fittings as sized by hydraulic calculation.
10. Sprinkler heads listed and approved for installation as will be indicated in the layout documents.
11. Thrust blocks, hangers, riser clamps, couplings, clamps, strapping, restraints, nipples, hose connections, nails, screws, bolts, nuts, inserts, rods, etc. as required to complete the system.
12. The calculated water velocity shall not exceed 20 feet per second in any segment of the designed system.

D. The following is not considered part of this Section:

1. Wiring of flow switches and valve switches.
2. Fire extinguishers and cabinets.

1.03 DESIGN CRITERIA

- A. System shall be designed in accordance with NFPA 1, 13, 14, 20, 24, 25, 101, 101A and 241. System shall also conform to all State and local requirements, including the Florida Fire Prevention Act.
- B. System shall include all materials, piping, sprinklers, flow switches, tamper switches, control panels and other devices and appurtenances required and necessary to provide a 100% fire sprinklered building in accordance with NFPA 13.

1.04 QUALITY ASSURANCE

- A. System conforming to Design Criteria in paragraph 1.02 above.
- B. Manufacturers of Major Components: Company specialized in manufacturing of types of fire protection equipment and materials required for this Project and with minimum ten years documented experience.
- C. Inspections: Comply with NFPA and local regulatory agencies.

1.05 WARRANTY

- A. Submit under provisions of Section 01701.
- B. Warranty: Include one year coverage for materials and workmanship.

1.06 CODES AND STANDARDS

- A. Install fire protection systems in accordance with the following National Fire Protection Associations Standards:
 1. NFPA 1 – Uniform Fire Code
 2. NFPA 13 – Standard for the Installation of Sprinkler Systems
 3. NFPA 14 – Standard for the Installation of Standpipes and Hose Systems

4. NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection
 5. NFPA 24 – Standard for the Installation of Private Fire Service Mains and their Appurtenances
 6. NFPA 25 – Standard for the Inspection, Testing, and maintenance of Water Based Fire Protection Systems
 7. NFPA 101 – Life Safety Code
 8. NFPA 101A – Guide on Alternative Approaches to Life Safety
 9. NFPA 241 – Standard for Safeguarding Construction, Alteration and Demolition Operations
- B. Provide fire protection products which have U.L. listing or are listed in the “Factory Mutual Approval Guide.” Preferred products shall be both U.L. and F.M. approved and listed.
- C. Comply with Fire Department regulations for sizes hose threads and arrangement of connections for fire department equipment to standpipe fire department valves roof manifolds and siamese fire department connections and NFPA 1963.

1.07 SUBMITTALS

- A. Submit manufacturer’s technical product data and installation instructions for protection materials and products.
- B. Submit shop drawings, including all information as required by NFPA and other agencies to the local authority having jurisdiction for approval. Submit two (2) approved copies, bearing stamp of the local authority having jurisdiction before proceeding with fabrication and installation.
- C. Submit “Contractor’s Covering Materials and Installation” upon completion of fire protection piping work which indicates that work has been tested in accordance with NFPA 13, and NFPA 24 and also that system is operational, complete and has no defects.
- D. At project closeout, submit record drawings of installed fire protection piping and products, in accordance with requirements of Section 01720.
- E. Submit maintenance data and parts list for fire protection materials and products. Include this data, product data, shop drawings, approval drawings, approved calculations, certificate of installation and record drawings in maintenance manual, in accordance with requirements of Section 01730.

1.08 WATER SUPPLY

- A. Flow test(s) shall be obtained in accordance with NFPA approved methodology from an approved source as directed by the Fire Marshal. This data shall be used in system design and hydraulic calculation..
- B. Maximum allowable velocity in sprinkler system piping shall be 20 feet per second.

PART 2 - PRODUCTS**2.01 GENERAL**

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities to comply with installation requirements.
- B. All materials and products shall be new and UL or FM listed for fire protection use.
- C. Provide proper and appropriate identification signs and markings for piping, standpipe and riser control valves, inspector's test, drains and other necessary locations per NFPA except otherwise required.

2.02 STEEL PIPING

- A. Piping:
 - 1. Piping 1" to 2" shall be schedule 40 black steel, ASTM specifications A53, A120 or A135.
 - 2. Piping 2-1/2" and larger shall be Schedule 10 black steel, ASTM specifications A53, A120 or A135.
 - 3. All exposed piping shall be galvanized. Galvanized painting not acceptable.
- B. Fittings:
 - 1. All fittings 2" and smaller to be cast iron screwed.
 - 2. All fittings 2-1/2" and larger to be mechanical grooved couplings, Victaulic or equal.
 - 3. All exposed fittings to be galvanized. Galvanized painting not acceptable.

2.03 GROOVED PIPING PRODUCTS

- A. IPS Grooved & Plain End FIT® Piping Systems
 - 1. Fire protection piping systems, as further detailed below, shall be installed by using Victaulic mechanical pipe couplings of a bolted or mechanical locking device type, with central cavity pressure-responsive gaskets, for use on wet and dry automatic sprinklers, inspector drain lines, outside protection, low pressure carbon dioxide, FM-200, Halon and Halon replacement systems.
 - 2. All materials and products shall be either Underwriters Laboratories listed (Canada and USA) or Factory Mutual Approved, and installed in accordance with NFPA Standard 13, other applicable Standards and manufacturer's published recommendations. Grooved end product manufacturer to be ISO-9001 certified.
 - 3. To assure system integrity and performance, all mechanical couplings, fittings, flanges, grooved valves and bolted branch outlets shall be furnished by the same manufacturer (Victaulic Company of America). All gaskets shall be of the central cavity-pressure-responsive design.
- B. Pipe (Standard/Lightwall): Pipe shall be prepared in accordance with the latest published Victaulic specifications, ANSI/AWWA C-606, UL, FM NEPA or other standards as applicable.
 - 1. Steel Pipe - Shall be steel pipe conforming to ASTM A-135, A-795 or A-53.

2. Grooved End Pipe - Shall be grooved utilizing Victaulic Vic-Easy® roll grooving tools or prepared in accordance with Victaulic cut grooving specifications.
3. Hole Cut Pipe - Shall have a machine cut hole at a predetermined position, on the centerline of the pipe, of a size to receive the housing locating collar, in accordance with Victaulic specifications.
4. Plain End for FIT® Products - Pipe ends shall be square cut and thoroughly cleaned on the OD, for 1" (25 mm) from the pipe end to remove pipe coatings, mill scale, rust and raised weld beads. OD burrs and sharp edges shall be removed. Pipe shall be marked 1-1/2" (38 mm) from the end and pipe end configuration shall be in conformance with Victaulic specifications.

C. Mechanical Couplings and Gaskets

As manufactured by Victaulic Company of America or equivalent shall be cast of ductile iron conforming to ASTM A-395, Grade 65-45-15, and ASTM A-536, Grade 65-45-12, with bolts/nuts conforming to ASTM A-183. Standard Grade "E" gaskets to be used for all water supply systems. Style 005 shall have Grade "E" (Type A) gaskets for wet fire protection sprinkler service (Flush-Seal® for dry service). Victaulic recommends the use of Grade "L" (Silicone) FlushSeal® gaskets for all dry systems operating below 0 degrees F (-18 degrees C). Grade "E" (Type A) coupling gaskets to be supplied with the Vic-Plus™ System, a factory applied dry, non-toxic lubricant.

1. Rigid Joints - Shall be Victaulic FireLock™ Style 005 or equivalent, 1 1/4"-8" (DN32-DN200), Zero-Flex® Style 07, 1-1/2"-24" (DN40-DN600) or Style HP-70, 2"-12" (DN50-DN300) couplings with gasket, and zinc electroplated bolts/nuts. Rigid couplings shall be of the angle pattern bolt pad type, and shall provide system support and hanging requirements in accordance with NFPA 13.
2. Flexible Joints - Shall be Victaulic Style 75, FireLock™ VIC-FLEX™ or equivalent 1-1/2"-8" (DN40-DN200), Style 77, 3/4"-24" (DN20-DN600), or Style 791, 2"-8" (DN50-DN200) couplings with Grade "E" standard gaskets and zinc electroplated bolts/nuts.
3. Reducing Joints - Shall be Victaulic 750 or equivalent Reducing Couplings 2"-8" (DN50-DN200) with Grade "E" standard gaskets and zinc electroplated bolts/nuts for direct connection of pipe of different sizes.
4. Outlet Couplings - All joints designated Outlet Couplings, or where feasible to replace reducing outlet tees, shall be Victaulic Style 72 or equivalent outlet couplings 1-1/2"-6" (DN40-DN150) (specify grooved, female or male threaded outlet) with Grade "E" standard gaskets and zinc electroplated bolts/nuts.

D. Victaulic Flange Adapters

1. Victaulic-FireLock™ Flange Adapter Style 744 - 2"-8" (DN50-DN200) for connection to ANSI CL 125 or CL 150 flanged components.

E. Valves - Grooved End

1. Check Valves
 - a. Shall be Victaulic Series 717 FireLock™ Check Valve or equivalent. Ductile iron body to ASTM A-395, grade 65-45-15, and ASTM A-536, Grade 65-45-12, stainless steel spring and shaft, rated to 250 psi (1725 kPa). Suitable for anti-water hammer service and horizontal or vertical installation. 2-1/2"-3" (DN65-DN80) PPS coated, aluminum bronze non-slam tilting disc with Grade "E" EPDM seal, and Underwriters Laboratories Listed (Canada and USA). 4"-12" (DN100-DN300) - Black enamel painted body with integrally welded on nickel

- alloy seat, Grade "E" EPDM encapsulated ductile iron disc, Underwriters Laboratories Listed (Canada and USA), and Factory Mutual Approved.
- b. Shall be Victaulic Series 717R FireLock™ Check Valve or equivalent. Black enamel painted ductile iron body to ASTM A-395, grade 65-45-15, and ASTM A-536, Grade 65-45-12, 4"-8" (DN100-DN200), Grade "E" EPDM encapsulated ductile iron disc, stainless steel spring and shaft, rated to 200 psi (1370 kPa). Suitable for anti-water hammer service and horizontal or vertical installation. Provided drilled, tapped and plugged downstream for 2" (DN50) drainage outlet and ½" (DN15) pressure taps both upstream and downstream of the disc. Underwriters Laboratories Listed (Canada and USA), and Factory Mutual Approved.
2. Butterfly Valves
- a. Shall be Victaulic Series 705W or equivalent, Underwriters Laboratories Listed (Canada and USA) for UL Butterfly Specification 1091 and Factory Mutual Approval Standard 1112, sizes 2-1/2" through 12" (DN65 through DN300), supplied with a ductile iron body conforming to ASTM A-395, Grade 65-45-15 and ASTM A-536, Grade 65-45-12, coated with a polyphenylene sulfide blend, a disc of ductile iron conforming to ASTM A-395, Grade 65-45-15 and ASTM A-536, Grade 65-45-12, with EPDM coating providing bubble tight shut-off. Sizes 2-1/2" through 12" (DN65 through DN300) shall have an approved weatherproof manual actuator suitable for indoor or outdoor use with two pre-wired single pole, double throw supervisory switches monitoring the open position as specified on the drawings. The Series 705 is supplied with grooved ends for installation with Victaulic grooved end couplings and rated for service up to 300 psi (2065 kPa) working pressure. . The Series 705W can be supplied with a ¼" (DN8) tap on the inlet side of the valve for use with Victaulic Series 756 Dry and Series 758 Actuated Check Valves. Valves shall be installed in accordance with the latest published Victaulic specifications.
3. Ball Valves
- a. Shall be Victaulic FireLock™ Series 728 or equivalent, Underwriters Laboratories Listed (Canada and USA) with flow characteristics exceeding UL Specification 1091 and Factory Mutual Approval Standard 1112, sizes 1" through 2" (DN25 through DN50), supplied with bronze body conforming to ASTM 584 Alloy 844, chrome plated brass ball, 316 stainless steel blowout proof stem, and TFE seat. They shall have an approved weatherproof manual actuator suitable for indoor or outdoor use with two pre-wired single pole, double throw supervisory switches monitoring the open position as specified on the drawings. Supplied with grooved ends in 1-1/4" through 2" (DN35 through DN50) for installation with Victaulic grooved end couplings, with threaded ends available in all sizes. The Series 728 is rated for service up to 350 psi (2410 kPa) working pressure and can be supplied with a ¼" tap on the inlet side of the valve for use with Victaulic Series 756 Dry and Series 758 Actuated Check Valves. Valves shall be installed in accordance with the latest published Victaulic specifications.

4. Alarm Check Valves
 - a. Shall be Victaulic FireLock™ Series 751 1-1/2"-8" (DN40-DN200) or equivalent spring assisted Alarm Check Valves, as Underwriters Laboratories Listed (Canada and USA) and Factory Mutual Approved, for vertical or horizontal installation, supplied with Grade "E" EPDM clapper seal, housing cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, serviceable without removal from the line, with grooved 1 1/2"-8" (DN40 – DN200) or flange by groove 4"-8" (DN100-DN200) ends for installation with ANSI Class 150 flange or Victaulic grooved end couplings as applicable, 1-1/2"-6" (DN40-DN150) rated for service up to 300 psi (2065 kPa) working pressure, 8" (DN200) rated for service up to 225 psi (1550 kPa) working pressure.

2.04 MATERIALS

- A. Hangers: Type listed for fire protection use. All exposed hanger material to be corrosion resistant.
- B. Valves: Self-indicating type, listed for fire protection use; Mueller or equal.
- C. Flow Switches and Tamper Switches – Notifier or equal.
- D. Sprinklers – Central, Reliable, Viking.
 1. Concealed sprinkler heads shall be used wherever possible throughout the finished spaces of this project. Cover plate color or chrome finish shall be approved in writing by the architect prior to purchase or installation of sprinkler units. Semi-recessed heads shall be the secondary choice for all finished spaces. Submit to architect for approval any and all sprinkler head colors and escutcheon finishes prior to purchase or installation.
 2. Unfinished areas shall be permitted to be protected by rough finish brass sprinkler heads. Note all sprinklers in unconditioned spaces shall be provided with corrosion protection equivalent to wax or polyester coating.
 3. Unfinished Ceilings – Brass upright.
 4. Sprinkler Heads - Shall be Victaulic Model V, Underwriters Laboratories Listed (Canada and USA), with frame of die cast brass, Teflon encapsulated Belleville spring seal, and frangible glass bulb. The glass bulbs are available in standard and quick response with various temperature ratings according to application requirement.
 - a. Standard Commercial - For light and ordinary hazards, Quick response, in upright, pendent, recessed pendent, horizontal sidewall, or recessed horizontal sidewall configurations.
Standard Orifice (K= 5.6)
Large Orifice (K=8.0)
 - b. Residential - Quick response, in pendent, recessed pendent, horizontal sidewall, recessed horizontal sidewall, adjustable flush pendent, low flow concealed pendent.
- E. Fire Department Connection – Rough Brass Finish.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. The fire protection system shall include all NFPA specified accessories including signs, test connections and drains.
- B. Comply with requirements of NFPA 13 and NFPA 24 for installation of fire protection piping materials. Install piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that piping systems comply with requirements and serve intended purposes.
- C. Coordinate with other work, including plumbing piping, as necessary to interface components of fire protection piping properly with other work.

3.02 TESTING

- A. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for a period of 2 hours, at not less than 200 psi. Check system for leakage at joints. Measure hydrostatic pressure at low point of each system or zone being tested. Any drop in pressure will not be permitted.
- B. Repair or replace piping systems as required to eliminate leakage in accordance with NFPA standards and retest as specified to demonstrate compliance and to satisfaction of the Engineer and Owner.

END OF SECTION

SECTION 16010
SUPPLEMENTARY GENERAL CONDITIONS

PART 1 - GENERAL

1.01 RELATED WORK

- A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 QUALITY ASSURANCE

- A. Supervisory Qualifications: The electrical work on the project shall be under the direct supervision of a licensed Journeyman.
- B. Qualifications of Installers:
 - 1. For the actual fabrication, installation, and testing of the work of this section, uses only thoroughly trained and experienced personnel who are completely familiar with the requirements of this work and with the installation recommendations of the manufacturers of the specified items.
 - 2. In acceptance or rejection of installed electrical systems, no allowance will be made for lack of skill on the part of the installers.

1.03 DRAWINGS

- A. The intent of the drawings and specifications is to obtain a complete and satisfactory installation. An attempt to separate and completely define the work of Division 16000 has been made. Separate divisional drawings and specifications shall not relieve the Electrical Contractor from full compliance of the work of his trade indicated on any drawings or in any section of the specifications.
- B. Examine all drawings and specifications carefully prior to submitting a bid. The Electrical Contractor will be required to install, and/or connect with appropriate services all items or equipment furnished by others as shown on any of the drawings without additional expense to the owner.
- C. Architectural drawings take precedence over Mechanical or Electrical drawings with reference to building construction. Mechanical and Electrical drawings are diagrammatic, but shall be followed as closely as actual building construction and work of other trades permit.
- D. Changes from drawings necessary to make the work of the electrical contractor conform to the building as constructed, or to fit work of other trades, or to comply with the rules of bodies having jurisdiction, shall be made by the Electrical Contractor at his own expense.
- E. Field coordinate with other trades in ample time to build all chases and openings, set all sleeves, inserts and concealed materials and provide clearances that may be required.
- F. The term, "provide" used in this Section of the specifications, shall include all labor, materials and equipment necessary to install any item or system indicated on either plans or specifications, including items called for, implied or normally part of the equipment or system. The finished installation shall be complete and fully operational before final acceptance.

- G. The Architect or Engineer reserves the right to make any reasonable changes (approximately six feet) in the location of outlets, fixtures, switches, receptacles, or equipment prior to the rough-in of such without any additional cost to the Owner.
- H. The Electrical Contractor is responsible for and shall pay for all access panels required in the architectural finishes or surfaces to provide access to the junction and pull boxes, ballasts, terminal cabinets or other devices provided and located by the Electrical Contractor. The access panel shall be installed by the trade constructing the base to which the access panel will be installed.
- I. The Electrical Contractor is responsible for design, fabrication and erection of all supplementary structural framing required for attachment of hangers or other devices to support electrical equipment.
 - 1. Framing members shall be designed for their actual loads, with allowable stresses set forth in AISC specifications and the AISC code, without excessive deflection and with consideration for rigidity under vibration. Supplementary framing, including design loads, member size and location shall be clearly shown on shop drawings for construction of supplementary framing.
 - 2. No cutting or drilling of holes in structural member will be permitted, except where written permission has been obtained from the Architect.

1.04 EXPLANATION TO BIDDERS

- A. No oral explanations in regard to the meaning of drawings and specifications will be made and no oral instructions will be given before the award of the contract. Discrepancies, omissions or doubts, as to the meaning of drawings and specifications, should be communicated in writing to the Engineer for interpretation. Bidders should act promptly and allow sufficient time for a reply to reach them before the submission of their bids. Any interpretation made by the Engineer will be in the form of an addendum to the specifications, which will be forwarded to all bidders. Receipt of the addendum shall be acknowledged by the bidder on his bid form.

1.05 BID REQUIREMENTS

- A. Before submitting his proposal, the bidder is required to visit the site of the proposed work and familiarize himself with the nature and extent of the work and any local conditions that may, in any manner, affect the work to be done or the equipment, materials and labor required. He is also required to carefully examine the plans and specifications and to inform himself thoroughly regarding any and all conditions and requirements that may, in any manner, affect the work to be performed under the contract. Ignorance on the part of the Contractor will in no way relieve him of the obligations and responsibilities assumed under the contract.
- B. In assembling his bid, the Contractor shall assemble a price based on these specifications and drawings as shown, and with all materials and equipment exactly as specified. This figure shall be known as the "Base Bid". All prices must have this base bid clearly stated to be considered. Alternate equipment may be quoted as an "add" or "deduct" item from the base bid in accordance with the specifications on substitutions.
- C. If asked, the Contractors bidding on this project shall show evidence of having recently completed a similar job of like size and complexity. If the low bid contractor does not have sufficient financial resource, skilled labor, technical competence, or experience, he shall be not awarded the contract.

1.06 SUBSTITUTIONS

- A. Each bidder represents that his bid is based upon the materials and equipment described in this Division of the specifications.
1. No substitutions will be considered unless a written request has been submitted to the Architect for approval twenty days prior to receipt of bids. Substitutions requested after that date will receive no consideration. Submittal shall include the name of the materials or equipment for which it is to be substituted, substituted equipment model numbers, drawings, cuts, performance and test data and any other data or information necessary for the Architect to determine that the equipment meets all specifications and requirements. If the Architect approves any proposed substitutions, such approval will be set forth in writing.
 2. Substituted equipment with all accessories installed or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems of this or other trades as a result of substitutions shall be made at the Contractor's expense and Contractor shall so state in his written request for substitution.
 3. Approved equal manufacturers or products may be provided elsewhere in these specifications and drawings. These are manufacturers or items which are known to be functionally equivalent to basis of design manufacturers and equipment. These alternatives are provided to produce a competitive bidding yielding a better value for the consumer. These items may and often do vary in specific characteristics, connections, and required services. The contractor remains liable and responsible for all coordination of other related systems, equipment, services, etc. There are a number of possible ramifications from utilizing other than the design basis equipment outside of changes to connection sizes and styles. These changes will need to be performed by the electrical and other contractors or they will need to contract with the engineer(s) of record to provide new coordinated drawings. All of these associated costs for utilizing equipment not selected on drawings as basis of design are to be borne by the contractor.

1.07 BID ALLOWANCES

- A. Provide allowances in Electrical subcontract bid to provide and install the quantity of fixtures of type noted in Specification Section 16511 at the unit material cost indicated.

1.08 SUBMITTALS

- A. Submit items for this Division as follows:
1. Submit all Division 16000 submittals at one time and in one integral group. Piece-by-piece submission of individual items will not be acceptable. The Architect/Engineer may check the contents of each submittal set upon initial delivery and if not complete as set forth herein, submittal sets may be returned to the Contractor without review and may not be accepted until made complete.

2. Division 16000 submittals must be delivered to the Architect/Engineer within thirty days from official notice to proceed. Any delays arising directly or indirectly from deliverance of submittals after this time shall be the Contractor's responsibility. Allow ten (10) working days from date of receipt for Architect/Engineer's review.
- B. Submittal items shall include materials, apparatus and equipment as indicated under each Section of this Division and in compliance with the General Conditions.
- C. Shop drawings shall include sufficient information to indicate compliance with specifications. Data shall include illustrations, catalog sheets, drawings and certifications. Each sheet shall show the manufacturer's name or trademark.
- D. At the time of each submission, the Contractor shall call the Architect/Engineer's attention to any deviations from the Contract Documents and shall plainly mark the deviations on the shop drawings.
- E. Manufacturer's Names and Catalog Numbers: In some instances, specific references have been made to one or more manufacturers' name and catalog numbers. It should be noted that such use does not indicate that the material and equipment specified is necessarily an "off the shelf" item. Variances may be due to the requirement of a desired finish, material or other modification. The Electrical Contractor shall ascertain that such modifications are fully considered.
- F. Submittal cover sheet shall bear the stamp of the General Contractor indicating the approval of the submittal contents to meet the intent of the construction documents.

1.09 FAMILIARITY WITH LAWS AND CODES

- A. The bidder is assumed to be familiar with all Federal, State and Local laws, ordinances, rules and regulations that in any manner affect the work. Ignorance on the part of the bidder will in no way relieve the bidder from responsibility to meet these requirements.

1.10 ORDINANCES AND REGULATIONS

- A. All work shall conform to all Federal, State and Local laws, ordinances or regulations governing the installation of the specified equipment. If the work as laid out, indicated or specified is contrary to or conflicts with local laws, ordinances or regulations, the Contractor shall report these conflicts to the Architect/Engineer before submitting a bid. The Architect/Engineer will then issue instructions to all bidders to clarify the conflict.
- B. If the Contractor fails to notify the Architect/Engineer of conflicts or omissions as noted above, all changes required to comply with local ordinances and regulations shall be made without additional expense to the Owner.

1.11 PERMITS AND FEES

- A. The Electrical Contractor shall obtain all necessary permits and inspections required for the electrical portion of the work and shall pay all charges incidental thereto.
- B. The Electrical Contractor shall deliver to the Architect/Engineer all certificates of inspection issued by Authorities Having Jurisdiction

1.12 CODES AND INSPECTIONS

- A. The installation shall comply with all laws applicable to the electrical installations, which are enforced by the authority having jurisdiction. The following codes shall apply to this project:
 - 1. NFPA 101, 2012
 - 2. FBC 2010
 - 3. Florida Fire Prevention Code
 - 4. NFPA 1, 2012 Edition Uniform Fire Code, Florida Edition
 - 5. NFPA 70 (2011 Edition)
 - 6. NFPA 780 (2004) Lightning Protection Code
- B. In any specific case where different sections of any aforementioned codes or these plans and specifications specify different materials, methods of construction or other requirements, the most restrictive shall govern. In the case of any conflict between a general provision and a special provision, the special provision shall govern.
- C. All materials shall be listed by a nationally recognized testing laboratory, as conforming to its standards, where such a standard has been established for the particular type of material in question.
- D. Where Contract Document requirements are in excess of code requirements and are permitted under the code, the Contract Documents will govern.

1.13 SINGULAR AND PLURAL REFERENCES

- A. Singular references in specifications shall not be construed as requiring one (1) device if multiple devices are indicated on the drawings.

1.14 MATERIALS

- A. Materials and equipment shall be new and in good condition. The commercially standard items of equipment and the specific names mentioned herein are intended to fix the standards of quality and performance necessary for the proper functioning of the electrical work.
- B. Since manufacturing methods vary, reasonable minor equipment variations are expected. However, performance and material requirements for the specified equipment are the minimum acceptable standards. The Architect/Engineer retains the right to judge equality of equipment that deviates from the specifications.

1.15 IDENTIFICATION OF EQUIPMENT

- A. All electrical equipment shall be identified by means of nameplates permanently attached to the equipment. Nameplates shall be engraved laminated plastic with letters at least 3/8" high.
- B. Nameplate designations shall correspond to the identifications on the "record drawings".
- C. Refer also to Specification Sections 16170 & 16160 for additional nameplate requirements.

1.16 OPERATING AND MAINTENANCE BOOKS

- A. The Electrical Contractor shall provide the Owner's Representative with operating instructions and maintenance data books for all equipment and materials furnished under this division. Provide Engineer with receipt of transfer to Owner.
- B. The Electrical Contractor shall submit four (4) copies of operating and maintenance data books to the Architect/Engineer for review four (4) weeks before final inspection of the project. All data shall be assembled in a single completely indexed volume and shall identify the size, model, and features indicated for each item.
- C. The following information shall be included where applicable:
 - 1. Identifying name and mark number
 - 2. Locations (Where several similar items are used, provide a list.)
 - 3. Complete nameplate data
 - 4. Certified record drawings and shop drawings
 - 5. Parts lists
 - 6. Wiring diagrams
 - 7. Manufacturers' operating and maintenance instructions, with all non-applicable information deleted.
 - 8. Equipment warranties.

1.17 DATE OF COMPLETION AND TESTING OF MECHANICAL/ELECTRICAL SYSTEMS

- A. The date for all the final acceptance tests by the Engineer shall be sufficiently in advance of the contract completion date to permit the execution of any adjustments and/or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the number of days allotted for completion of the contract. Re-tests shall not relieve the Contractor for this Division of his contract completion date responsibility.

1.18 GUARANTEE AND SERVICE

- A. In addition to the guarantee of equipment by the manufacturer of each piece of equipment specified herein, the Electrical Contractor shall also guarantee such equipment and shall be held for a period of one (1) year from final acceptance test for necessary adjustments and/or replacements of all defective equipment, and materials and workmanship without expense to the Owner.
- B. The Contractor shall furnish maintenance and service for one (1) year from final acceptance of the contract for all portions of the system. Such service for the one year period includes the following:
 - 1. Necessary adjustment and/or replacement of all defective equipment and materials furnished.
- C. Service and replacement of light bulbs shall be limited to thirty days after final acceptance of the job.
- D. Upon expiration of each of these limits noted herein, the maintenance, including labor and material costs, shall be at the Owner's expense.

1.18 ACCEPTANCE

- A. As a precedent to requesting a final inspection and release of retained monies, the Electrical Contractor shall:
 - 1. Complete all work required under the electrical section of the specifications.
 - 2. Submit four (4) certified copies of final test data to the Architect/Engineer.
 - 3. Furnish a complete set of "as built" reproducible tracings of the Contractor's work to the Architect/Engineer.
 - 4. Submit four (4) copies of operating and maintenance books to the Architect/Engineer.
 - 5. Provide resolution to all issues noted on Engineers' Field Reports and Final Punchlists.
 - 6. Provide all copies of certificates of inspection issued by Authorities Having Jurisdiction.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION**3.01 GENERAL**

- A. Fabrication, erection and installation of the complete electrical system shall be done in a first class workmanlike manner by qualified personnel experienced in such work and shall proceed in an orderly manner so as not to hold up progress of the project.
- B. The Electrical Installer shall check all areas and surfaces where electrical equipment material is to be installed, removed or relocated and report any unsatisfactory conditions before starting work.
- C. Commencement of work signifies this Installer's acceptance of existing conditions. In the acceptance or rejection of the finished installation, no allowance will be made for lack of skill on the part of workmen.
- D. After completion of the installation, all equipment, devices, fixture and other work shall be thoroughly cleaned. Remove all foreign matter, paint, dirt, grease, stickers and temporary labels from all fixtures, equipment, devices and other work. Remove all rubbish and debris accumulated during the installation work.

3.02 TEMPORARY POWER, LIGHTING AND FIRE ALARM

- A. Furnish and install all temporary electrical facilities required for safe construction and operations.
- B. Provide electrical power distribution system to comply with National Electrical Code (NEC) and Occupational Safety and Health Administration (OSHA) requirements.
- C. Provide lighting system to comply with National Electrical Code (NEC) and Occupational Safety and Health Administration (OSHA) requirements to provide adequate lighting for work to be safely completed.
- D. Provide temporary fire alarm system (FAS) to comply with National Fire Alarm Code or

International Fire Code requirements, as applicable to Authority Having Jurisdiction (AHJ).

- E. Where demolition work is included as part of this work, electrical installer shall also make the provisions shown below. Refer to "Minor Electrical Demolition" specification.
1. Existing smoke detectors located within the limits of the area of this work may be replaced with heat detection devices to prevent false alarms from airborne dust from construction operations.
 2. Electrical installer shall ensure all existing electrical boxes, cables and conduits remaining above the finished ceiling after demolition work is completed are properly covered, supported and in compliance with all current codes.
 3. Cost provisions for any additional box covers, supports, hangers and other equipment identified as necessary to comply with these codes shall be separately identified. If these costs are not separately identified, it shall be assumed that costs for these provisions are included in this work and shall be provided at no additional cost to the owner.

3.03 PERFORMANCE TESTS

- A. Thoroughly test all fixtures, services and circuits for proper operating condition and freedom from grounds and short circuits before acceptance is requested. All equipment, appliances, and devices shall be operated under load conditions.

3.04 AS-BUILT DRAWINGS

- A. During progress of the work, maintain an accurate record of the installation of the system, locating each circuit precisely by dimension. Upon completion of the installation, transfer all record data to blue line prints of the original drawings.

3.05 OPERATING INSTRUCTIONS AND MANUALS

- A. Instructions: Without additional charge to the Owner, furnish competent instruction to the Owner in the care, adjustment and operation of all parts of the electrical equipment and systems.
- B. Manuals: Upon completion of the work, prepare and deliver to the Owner two (2) sets of complete operating and maintenance manuals for the systems and major equipment installed. Include catalog data, shop drawings, wiring diagrams, performance curves and rating data, spare parts lists and manufacturer's operating and maintenance data.
- C. Other: The above requirements are in addition to specific instructions and manuals specified for individual systems or equipment.
- D. Drawings: All electrical plans, schedules, drawings and specifications shall be equally considered to be part of the Contract Documents, with no exceptions, exemptions or exclusions. There is no consideration of precedence or preference for any of these components as being exclusive of the other and all of them shall comprise a complete set of Contract Documents. Each of these components of the Contract Documents shall bear equal weight, influence and consideration. If there are conflicts between any of these components of the Contract Documents, the Installer shall notify the Engineer prior to proceeding with the work in question.
1. The electrical plans and drawings show the general arrangement of all panels, luminaires, devices, raceways, equipment, etc. and shall be followed as closely as actual building construction and the work of other trades will permit.

Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required.

- a. The Installer shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, elbows, pull-boxes, and accessories as may be required to meet such conditions.
 - b. Where there are discrepancies between the electrical and architectural drawings showing elevations or locations of devices, fixtures or equipment, the location or elevation as shown on the architectural plans and drawings shall prevail. Notify the Engineer when these discrepancies are discovered.
 - c. Mechanical equipment, such as HVAC units, and mechanical devices, such as thermostats, are shown on both the electrical and mechanical plans and drawings, but the locations as shown on the mechanical plans and drawings shall prevail, when there are discrepancies are between the two.
 - d. Raceways and junction boxes for thermostats are part of this work but the devices and wiring for these devices shall be installed by others. Installer shall coordinate location of these devices with mechanical plans. Refer to the above note regarding locations of mechanical equipment and devices.
2. The Installer shall verify field measurements and dimensions governing the electrical work. No extra compensation shall be claimed or allowed on account of differences between actual dimensions and those indicated on the drawings.

3.06 LOCATION OF EQUIPMENT, SWITCHES, DEVICES AND OUTLETS

- A. The approximate locations of cabinets, luminaires, switches, panelboards, raceways, power outlets, equipment and other devices are indicated on the drawings; however, they are not intended to give complete and accurate information. Determine the exact location after thoroughly examining the general building plans and by actual measurements during construction, subject to the approval of the Architect or Engineer, as appropriate.
- B. Installer shall coordinate locations for all devices, gear and equipment shown with architectural, plumbing and mechanical plans prior to beginning electrical rough-in work and verify final locations of all these before starting rough-in work. Devices, gear and equipment may be relocated or moved up to ten (10) feet in any direction without additional cost to the owner. Where there are any concerns or questions about coordination or clearance problems, contractor shall prepare a written recommendation and submit for review and approval.

3.07 WARRANTY

- A. Deliver originals of all guarantees and warranties on this portion of the work to the Owner. Warrant all equipment, materials and workmanship for one year in accordance with the terms of this Contract.

3.08 CLOSE-OUT MATERIALS

- A. Prior to or at substantial completion of the project, deliver to the Owner the following if applicable:
 - 1. Keys to locks on cabinets, panelboards and control panels.
 - a. Keys, handles or apparatus used to operate switches, circuit breakers, etc.
 - b. Tools such as screwdrivers, wrenches, sockets, etc., used to install or remove tamper-proof screws, bolts, nuts and fastening devices.
 - c. Spare parts, fittings, fasteners provided with electrical equipment furnished as part of these specifications and drawings.
 - d. Provide Operating and Maintenance manuals and information, as required by Electrical Specification Section - Operation and Maintenance Information.

END OF SECTION

**SECTION 16110
RACEWAYS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. The General Provisions of the contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.
- B. Refer to Supplementary General Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all materials and equipment and performing all labor and services necessary for the complete installation of the system of conduits for power and lighting service, including all related system and accessories as shown by the drawings and herein after specified.

1.03 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metallic conduit.
- C. ENT: Electrical non-metallic tubing.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquid-tight flexible metal conduit.
- G. LFNC: Liquid-tight flexible nonmetallic conduit.
- H. RNC: Rigid non-metallic conduit.

PART 2 - PRODUCTS**2.01 BUSHINGS, LOCKNUTS AND CONNECTORS**

- A. Where rigid conduit enters a box of any description, the conduit shall be secured to the box with a locknut on the outside and a similar nut and bushings on the inside.
- B. Where electric metallic tubing enters such boxes, the connection between the connector and the box shall be made tight by an approved manner both on the inside and the outside of the box.
- C. Conduit terminations at the boxes shall be provided with bushings. Bushings for conductors through #8 AWG shall be galvanized, non-insulating type; for #6 AWG and larger conductors, bushings shall be insulated and selected for the size conduit involved.

2.02 CONDUIT

- A. Manufacturers:
1. Allied Tube & Conduit
 2. AFC Cable Systems, Inc.
 3. Alflec Inc.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 7. LTV Steel Tubular Products Company.
 8. Manhattan/CDT/Cole-Flex.
 9. O-Z Gedney, Unit of General Signal
 10. Wheatland Tube Co.
- B. All conduit installed in concrete floor slabs shall be Underwriter's approved hot-dipped rigid galvanized steel conduit or Schedule 40 PVC conduit.
- C. All conduit installed underground shall be Schedule 40 rigid polyvinyl chloride (PVC) or hot-dipped rigid galvanized steel conduit coated with an asphaltum paint approved by the Architect.
- D. All conduit installed exposed in exterior areas above finished grade shall be Underwriter's approved rigid hot-dipped galvanized steel. Conduit installed exposed in interior areas above finished floor shall be Underwriter's approved hot-dipped rigid galvanized steel or electrical metallic tubing, unless otherwise noted on the drawings.
- E. All conduit installed in or above ceilings or stud partitions shall be rigid galvanized steel conduit or electrical metallic tubing.
- F. PVC Schedule 40 conduit shall not be used above grade anywhere on the project. PVC conduit may not be used within the building.
- G. Electrical Metallic Tubing: All electrical metallic tubing shall be galvanized and conform to all pertinent requirements of the National Electrical Code.
- H. All flexible metallic conduit installed in wet or damp locations shall be liquid-tight (PVC extruded cover) and all installations in dry locations shall be flexible steel conduit (no cover), unless specifically noted otherwise.
- I. PVC Conduit: All polyvinyl chloride conduit shall be heavy-wall Schedule 40, with factory made bends, couplings and fittings.
- J. Connectors and Couplings: For electrical metallic tubing, compression, galvanized steel, tap-on or set, screw type fittings shall be used. For rigid steel conduit, threaded couplings and locknuts and bushings shall be used. For PVC, PVC couplings and fittings shall be used. Where PVC underground conduit connects to steel conduit, suitable threaded conduit adapter fittings shall be used. For flexible conduit, liquid-tight fittings shall be used with liquid-tight flexible conduit and compression fittings shall be used with flexible steel conduit.

- K. Conduit serving patient care/occupied areas shall be rigid galvanized steel or electrical metallic tubing. Patient care/occupied areas shall include, but not be limited to, the following: physical therapy rooms, patient rooms, patient toilet room, dining areas and similar areas.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify the electrical installation may be made in complete accordance with all pertinent codes and regulations and the original design.

3.02 DISCREPANCIES

- A. In the event of discrepancy, immediately notify the Architect/Engineer.
- B. Do not proceed with the installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.03 PREPARATION

- A. Coordinate the installation of electrical items with the work schedules of other trades to prevent unnecessary delays in the total work.
- B. Do not proceed with the installation in areas where there is any discrepancy until all such discrepancies have been fully resolved.

3.04 INSTALLATION OF RACEWAYS AND FITTINGS

- A. Conduit shall be of the sizes required to accommodate the number of conductors in accordance with the National Electric Code, or as noted on the drawings. The sizes shown on the plans may be increased if desired to facilitate the pulling of conductors. The minimum conduit size shall be one half inch (1/2").
- B. All conduit shall be concealed unless otherwise shown on the drawings. Concealed conduit run above the ceiling shall be supported from the roof structure, i.e., roof trusses, bar joints and shall be totally independent from ceiling and/or rated membrane construction. Where a ceiling of the lay-in type is used, the conduit must be installed high enough to permit removal of ceiling panels.
- C. Exposed conduit shall be run parallel with or at right angles to the building walls and supported from the walls or ceilings with straps or clamps secured with wood screws for wood construction, machine screws for metal construction, and expansion anchors with bolts for masonry or concrete slab construction, All exposed conduit runs shall be subject to approval.
- D. Underground conduit shall be laid at a minimum depth below grade of 36 inches, unless specifically noted otherwise.

- E. Conduit shall be continuous from outlet to outlet and from outlet to cabinet, junction or pull box. Conduits shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from point of service to all outlets.
- F. Approved Appleton, Crouse-Hinds, or O.Z. Manufacturing Company expansion fittings shall be installed in all rigid conduit and E.M.T. runs, where such conduit runs extend across expansion joints in the building.
- G. No conduit shall be trapped except where shown on the drawings.
- H. Conduit connection to a box which has no threaded hub for its reception shall be double lock-nutted with locknuts designed to bite into the metal. Provide an insulated bushing at each end of each conduit run. Use insulated bushings with separate locknuts on all conduit entering a panel cabinet. All conduits entering outlet boxes shall be provided with either insulated throat connectors or separate locknuts and insulated bushings. Bushings must be installed before any wire is pulled in. Refer to Paragraph 2.01 C.
- I. At rigid steel couplings, conduits shall be threaded so that they meet in the coupling. Right and left couplings shall not be used; conduit couplings of the Erickson type shall be used at locations requiring such joints.
- J. All threaded joints shall be made up with white lead applied to the male threads only.
- K. Conduit shall be secured in place and protected to prevent damage to work during construction. The ends of all conduit runs shall be plugged to avoid filling with plaster, etc. All conduit shall be blown out and/or swabbed clear of water and trash prior to pulling wire.
- L. Flexible conduit shall be used only where indicated on the drawings, or where specified otherwise.
- M. Conduit connections from outlet boxes, junction boxes, conduit, switch boxes, or motor controller to rotating or vibrating machinery or equipment shall be made with flexible conduit which shall be as short as possible with a maximum length of 36 inches.
- N. Conduit connections from outlet boxes to recessed lighting fixtures shall be made with 3/8" flexible conduit which shall have a maximum length of 72 inches, unless otherwise noted.
- O. PVC Conduit installed underground shall be encased in concrete with a minimum thickness of six (6) inches on all sides of the conduit in high traffic areas such as driveways, roads and other areas as indicated on the drawings.
- P. Where underground PVC conduit turns up to run above grade, the elbow and all conduit from the elbow up shall be rigid galvanized steel. Where the PVC conduit is encased in concrete, the transition to steel conduit shall be made within the concrete casing.
- Q. All telephone conduit routed to the telephone terminal wood backboard shall be terminated with an end bushing within six (6) inches of the edge of the backboard.
- R. All conduit penetrating a fire or smoke wall shall be sealed with an approved firestop material to preserve the rating of the firewall.

- S. All boxes and enclosures including conduits for emergency circuits shall be spot painted so that they will be readily identified as a component of an emergency circuit. Colors to be as follows:
- Yellow - Life Safety Branch
 - Orange - Critical Branch
 - Green - Equipment Branch
 - Red - Fire Alarm System
 - Purple - Other Emergency System wiring not covered above
(generator feeders, transfer switches, etc.)
- T. All metal feeder raceways associated with essential system shall have terminations equipped with grounding bushings in accordance with NEC 517-19.

END OF SECTION

**SECTION 16120
CONDUCTORS AND CABLES**

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary General Conditions.
- C. Refer to Raceways.

1.02 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction, current edition, including all revisions; National Electrical Contractors Association.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 83 - Thermoplastic-Insulated Wires and Cables, current edition, including all revisions.
- D. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- E. UL 486C - Splicing Wire Connectors, current edition, including all revisions; Underwriters Laboratories.
- F. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables, current edition, including all revisions; Underwriters Laboratories.
- G. UL 1569 - Metal-Clad Cables, current edition, including all revisions; Underwriters Laboratories.
- H. ASTM B 3 - Standard Specification for Soft or Annealed Copper Wire, latest edition; American Society for Testing and Materials.
- I. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft, latest edition; American Society for Testing and Materials.
- J. ASTM B 787/B 787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation, latest edition; American Society for Testing and Materials.

1.03 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all materials and equipment and performing all labor and service necessary for the complete installation of the system of conductors for power and lighting service, including all related raceways, devices, systems and accessories as shown by the drawings and herein after specified.

- B. Commencement of work signifies this Installer's acceptance of existing conditions. In the acceptance or rejection of the finished installation, no allowance shall be made for lack of workmen skill.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Cerro Wire LLC: www.cerrowire.com.
- B. Industrial Wire & Cable, Inc: www.iewc.com.
- C. Southwire Company: www.southwire.com.
- D. Alcan Aluminum Corporation; Alcan Cable Div.: www.alcan.com.
- E. American Insulated Wire Corp.; a Leviton Company: www.aiwc.com.
- F. General Cable Corporation: www.generalcable.com.

2.02 MATERIALS

- A. Provide products that comply with requirements of NFPA 70 and that are listed and classified by Underwriters Laboratories (UL) as suitable for the purpose indicated.
- B. All conductors #2 AWG and smaller shall be soft-drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B 3, ASTM B 8, or ASTM B 787/B 787M, with 600 volt insulation.
 - 1. Conductors #1 AWG and larger shall be permitted to be electrical grade compacted aluminum with 600 volt insulation, unless noted otherwise.
 - 2. Terminate aluminum conductors with tin-plated aluminum-bodied compression connectors. Fill connector body with anti-oxidant compound before installing conductor.
- C. Conductors and conduit sizes specified are based on copper AWG up to #4/0 and circular mils above #4/0.
 - 1. Conductor sizes 10 AWG and smaller shall be solid; Conductors #8 AWG and larger shall be stranded.
 - 2. Stranded conductors may only be terminated with UL or ETL Listed type terminations or methods. Stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.
 - 3. Conductors #6 and smaller shall be NEC standard dual rated Type THWN or THW thermoplastic, approved for operation at 75 degrees Celsius in dry and wet locations and 90 degrees Celsius within electric discharge lighting equipment as permitted in NEC 410.
 - 4. Use only building wire with Type THWN insulation in raceway or service-entrance cable.
 - 5. Conductors #4 and larger shall be NEC Standard rated Type THWN approved for operation at 75 degrees Celsius in dry and wet locations.
 - 6. In healthcare installations where branch circuits are fed from an isolation panel, use building wire with Type XHHW insulation installed in raceway to reduce losses.

- D. All wire and cable shall be of the same name brand, and shall be in the original wrapping.
- E. Type AC cable shall be permitted throughout facility and shall meet all requirements per the appropriate article of the NEC.

2.03 ALUMINUM CONDUCTORS

- A. The following requirements shall be met when Aluminum conductors are utilized:
 - 1. Aluminum alloy conductors shall be compact stranded conductors of a recognized Aluminum Association 8000 Series aluminum alloy conductor material (AA-8000 series alloy).
 - 2. It is the responsibility of the contractor to increase the size of the conduit, wire gutter, or enclosure, if necessary, to accommodate the aluminum conductors and meet allowable code requirements.
 - 3. It is the responsibility of the contractor to increase the size of the aluminum conductor to match the ampacity of the copper conductor circuit shown on the Drawings.
 - 4. The contractor shall submit a feeder schedule to the Engineer for all conductor substitutions indicating the aluminum conductor wire size and the conduit size. The contractor shall not begin the installation until written approval is granted by the Engineer.
 - 5. All aluminum conductors shall terminate on a mechanical screw-type connector or mechanical compression-type connector. Connector shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors, and sized to accept aluminum conductors of the required ampacity. When using compression-type connectors, the lugs shall be marked with wire size, die index, number and location of crimps and shall be suitably color-coded. Using a suitable stripping tool, remove insulation from the required length of the conductor. Wire brush the conductor and apply a listed joint compound. Tighten or crimp the connection per the connector manufacturer's recommendation. Wipe off any excess joint compound.
 - 6. When terminating aluminum conductors to aluminum bus, prepare a mechanical screw-type or compression-type connection. Bolts shall be anodized alloy and conform to current ANSI and ASTM chemical and mechanical property limits. Nuts shall be aluminum alloy and conform to current ANSI standards. Washers shall be flat aluminum alloy, Type A plain, standard wide series conforming to current ANSI standards. Lubricate and tighten the hardware per manufacturer's recommendations.
 - 7. When terminating aluminum conductors to copper bus, prepare a mechanical screw-type or compression-type connection. Bolts shall be plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to current ASTM standard or SAE grade 5. Nuts shall conform to current ANSI standards. Washers shall be steel, Type A plain, standard wide series conforming to current ANSI standards. Belleville conical spring washers shall be of hardened steel, cadmium plated or silicone bronze. Lubricate and tighten the hardware per manufacturer's recommendations.
 - 8. The final tightening torque shall be recorded for all aluminum conductor mechanical screw-type connections and provided in report form, in the completed O&M manuals.

9. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 10. The contractor shall perform an infrared survey of all aluminum conductor connections after the installation is complete and in normal service. Infrared surveys shall be performed during periods of maximum possible loading with at least 30% of rated load of the equipment being inspected. All connections with elevated temperatures shall be corrected by the contractor. The infrared survey results shall be provided in report form, in the completed O&M manuals.
- B. No copper-to-aluminum transitions permitted when splicing onto existing copper feeders.
- C. Insulation shall have a 600 volt rating.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Minimum size conductor installed shall be #12 AWG for all applications, except for special system circuits and where specifically noted otherwise.
- B. All lighting and receptacle branch circuit conductors shall be color coded. Feeder cables and service entrance conductors shall be color coded by use of colored plastic tape applied within six (6) inches of each conductor end. All color coding shall be with the same color being used with its respective phase or bus through the entire job as follows:

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

- C. No wires or cables shall be pulled into the conduit until the conduit system is complete and plastering is applied and dried. This does not refer to a white finish coat of plaster, which may be applied after the wires are pulled.
- D. All wiring for lighting and receptacles branch circuits shall be run as single-phase, two-wire circuits with equipment grounding conductor. A common neutral shall be permitted for multi-wire circuits where the available electrical service is three-phase, provided the circuits are supplied from different phases. If it is necessary that more circuits be placed in any run, a separate neutral must be provided for additional two-wire, three-wire or four-wire branch circuits.
1. No more than 6 current carrying conductors of multi-outlet circuits shall be permitted to be installed in a single raceway, regardless of size of conductors or raceway.
 2. Install conductors at each outlet, with at least 6 inches (150 mm) of slack conductor length.
- E. Conductors shall be continuous from outlet to outlet and from outlet to junction box or pull box. All splices and joints shall be carefully and securely made to be mechanically and electrically solid with solderless pressure connectors and insulated with vinyl

electrical tape and friction tape, if insulation is not provided in pressure type connector used.

1. All conductors shall be properly terminated in accordance with torque requirements specified in manufacturer's instructions.
 2. Aluminum terminations shall be treated with an oxide inhibiting compound prior to torquing.
 3. Where connection is made to any terminals of more than 30 amperes capacity and where conductors larger than #10 are connected to any terminal, CU/AL terminal lugs shall be bolted to the conductors.
 4. Where multiple connections are made to the same terminal, individual lugs for each conductor shall be used.
 5. Install 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 100 feet (30 m).
 6. Install 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet (60 m).
- F. All wire and cables for power, lighting, control and signal shall be continuous from origin to destination with proper splices as specified. At the end of these wires and cables, only sufficient slack shall be left as may be required for making proper connections. There shall be no unnecessary slack, but not less than 6 inches of slack at any junction box, outlet, device or terminal.
- G. Where conductors are to be connected directly to the devices without the use of lugs, such as occurs at side connections of lighting switches and plug receptacles, the conductors shall be formed into suitable loops to fit around the terminal screws.
- H. Where wires and cables are connected to metallic surfaces, the coated surfaces of the metal shall be polished before installing the mechanical connectors. The lacquer coating of conduits shall be removed where ground clamps are to be installed.
- I. The conductors terminating at each wired outlet shall be left not less than six (6) inches long at their outlet fitting to facilitate the installation of devices or fixture. Where more than one pair of conductors enters an outlet, the several pairs of conductors shall be neatly spliced and made mechanically and electrically secure. The conductors shall be not less than six (6) inches long at any junction box, outlet, device or terminal.
- J. Branch circuit wiring which supplies more than one fluorescent fixture through the wireway of other fixtures shall be approved for use at 90 degrees Celsius. Such fixture wireways shall be U.L. listed for through wiring.
- K. Wall switch outlets shall be wired to provide control of outlets indicated. All connections to single pole switches shall be made so that the "OFF" operation of the switch opens the ungrounded leg.
- L. Each wire in a pull box, junction box or equipment wire chamber shall be labeled with the proper panel letter and circuit number identification, and where two or more wires are spliced, each shall be labeled. Labels shall be printed numbers and letters on suitable plastic tape. Wires and cables shall be identified by suitable Brady or approved equal adhesive label tapes.
- M. No more than eight current carrying conductors shall be contained in any single raceway, unless noted otherwise.

- N. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

END OF SECTION

SECTION 16131
JUNCTION AND PULL BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of junction and pull boxes, including all related systems and accessories as shown by the drawings and hereinafter specified.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Junction and pull boxes 100 cubic inches in volume or smaller shall be standard outlet boxes. Those 150 cubic inches or larger shall be constructed as specified for cabinet construction and shall be furnished with covers. Boxes shall be coated inside and out to prevent corrosion.
- B. Boxes shall be sized in accordance with the requirements of the National Electrical Code, and junction boxes not used for service entrance duty shall not be smaller than four (4) inches square and 1-1/2 inches in depth with covers accessible at all times. Boxes on concealed conduit shall be set with covers flush with the finished plaster line, unless otherwise shown.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Junction boxes and pull boxes made of code gauge steel shall be furnished and installed where such boxes may be necessary to facilitate the pulling or splicing of cables. Boxes must be made accessible. Conduits shall enter these boxes through tight fitting clearance holes. Where required, suitable supports shall be provided in all pull boxes to support feeders passing through the boxes so that feeder conductors will not remain unsupported for a distance greater than three (3) feet.
- B. Junction boxes shall have only the holes necessary to accommodate the conduits at point of installation. All boxes shall have suitable provisions to secure covers.
- C. Junction boxes shall be securely attached to the building construction, using wood screws for wood construction, bolts for metal construction, and expansion anchors with bolts for masonry or concrete construction. Boxes flush mounted in tile or masonry construction shall be secured in place with cement mortar. Boxes flush mounted in ceiling shall be supported from building structure independent of the ceiling construction.

END OF SECTION

JUNCTION AND PULL BOXES
SECTION 16131 – 1

09/20/2017

**SECTION 16133
CABINETS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of the cabinets, including all related systems and accessories as shown by the drawings and hereinafter specified.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Cabinets shall be of code gauge steel with overlapped riveted or welded corners and with edges turned to receive trim. Each trim shall be of the same size as that of its cabinet or 1-1/2" oversize, according to whether the cabinet required is surface mounted or flush mounted. Trim shall be held in place by toggle bolts or other adjustable fasteners which will permit adjustment. Doors shall be provided with latches, locks and keys.
- B. Cabinets shall be Square D Company TF or TS Series 18"W x 24"H x 4"D as applicable for surface or flush mounting.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Cabinets shall be securely attached to the building construction, using wood screws for wood construction, bolts for metal construction, and expansion anchors with bolts for masonry or concrete construction.

END OF SECTION

**SECTION 16134
OUTLET BOXES****PART 1 - GENERAL****1.01 SECTION INCLUDES:**

- A. Wall and ceiling outlet boxes.
- B. Floor boxes.
- C. Pull and junction boxes.

1.02 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.03 REFERENCE STANDARDS

- A. NECA 1 – Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association, latest edition.
- B. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association, latest edition.
- C. NEMA OS 1 – Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association, latest edition.
- D. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association, latest edition.
- E. NFPA 70 – National Fire Protection Association – National Electrical Code; most recent edition adopted by authority having jurisdiction (AHJ), including all applicable amendments and supplements.

1.04 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of the outlet boxes, including all related systems and accessories as shown by the drawings and herein after specified.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Hubbell – RACO
- B. Thomas & Betts – Steel City
- C. Appleton Electric

- D. Arcade Metal Stamping
- E. Unity Manufacturing
- F. Communications Integrators, Inc
- G. Hubbell Wiring Devices-Kellems
- H. Legrand – Walker
- I. Hubbell – Killark
- J. Eaton – Cooper Industries – Crouse Hinds

2.02 MATERIALS

- A. At each outlet shown, furnish and install a box of suitable size and construction to serve the purpose properly. Furnish and install plaster rings where required in connection with adjacent plaster finish where these occur. In unfinished masonry walls, furnish and install handy boxes of such size as to permit them from being completely covered by the device plate. Boxes throughout shall be galvanized steel. All unused knockouts in boxes shall be filled or capped before plates or devices are installed.
- B. Ceiling outlets shall be four (4) inch octagonal boxes of the appropriate depth and furnished with 3/8" fixture studs fastened through from back of boxes. For plaster surfaces, furnish and install plaster rings and ears.
- C. At each switch or receptacle outlet shown, provide outlet box of (4) inches square and 1 ½ "in depth with extension ring as necessary for devices contained.
- D. Outlet boxes for all exposed work shall be of the cast type and manufactured by an approved vendor selected from the above list.
- E. Stamped steel outlet boxes shall be manufactured by an approved vendor selected from the above list.
- F. Cast metal outlet boxes shall be manufactured by an approved vendor selected from the above list.

2.03 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
- B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch (13 mm) male fixture studs where required.
- C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 2726.

2.03 FLOOR BOXES

- A. Floor Boxes: NEMA OS 1, fully adjustable, 1-1/2 inches (38 mm) deep.
- B. Material: Formed steel.
- C. Service Fittings: As specified in Section 26 2726.

2.04 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 26 2716.
- C. Surface Mounted Cast Aluminum Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
- D. In-Ground Cast Aluminum Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
- E. Fiberglass Hand-holes: Die molded glass fiber hand holes:

2.05 HINGED-COVER ENCLOSURES

- A. NEMA 250, Type 1, with continuous hinge cover and flush latch
- B. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2.06 CABINETS

- A. NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge.
- B. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- B. Boxes shall have only the holes necessary to accommodate the conduits at point of installation. All boxes shall have suitable provisions to secure covers.
- C. Each outlet and device box shall have sufficient depth to permit the equipment being installed within it to be properly mounted and it shall have sufficient clearance to prevent damage to any conductors, devices or other equipment installed within the box.
- D. Boxes shall be securely attached to the building construction, using wood, screws for wood construction bolts for metal construction, and expansion anchors with bolts for masonry or concrete construction. Boxes flush mounted in tile or masonry construction shall be secured in place with cement mortar. Boxes flush mounted in ceiling shall be supported from building structures independent of the ceiling construction.
- E. All outlet boxes shall be flush mounted within the wall regardless of wall construction, unless they are specifically shown as being used with exposed conduit.
- F. The edge of all outlet box extension rings shall be flush with the surface in which they are recessed. The Contractor shall be attentive to boxes set in masonry walls. The devices that fit into the outlet boxes shall be screwed tight before the cover plates are

installed. The cover plates shall not be used as a means of tightening the devices in place.

- G. Flush mounted outlet boxes in all exposed masonry walls shall be masonry boxes or shall be 4 inch square boxes with square cornered tile covers. The boxes or box covers shall have square edges and shall have the device holes inside the box.
- H. Extra deep type concrete boxes shall be used in concrete walls and slabs to permit entering and leaving of conduits and to avoid steel reinforcing rods.
- I. Wall switch outlets shown at door locations shall be installed on the lock side of the door, 4 inches from the jamb, unless otherwise indicated on the drawings. Door swings shall be verified from architectural drawings.
- J. Outlet boxes designated for information management shall be 4 inches square and shall have raised covers with rectangular opening in center.
- K. Outlet boxes for telephones shall be 4-11/16 inches square and shall have raised covers with rectangular opening in center.
- L. Outlets shall be located approximately as shown on the plans. Exact mounting heights for all outlets shall be determined at the building site and shall be verified by the Contractor from architectural drawings which indicate casework and other architectural conditions. Outlets shall be located so as not to split the top of wainscot, backsplashes, or to be obstructed by equipment of any type indicated or specified. Where outlets are shown on the drawings as being adjacent and different mounting heights are specified for each, they shall be mounted one directly over the other, on the centerline of the group or on the centerline of the room.
- M. Where outlets are installed in waterproofed walls or columns, a 6" x 6" x 3" deep wood box shall be placed in the forms before the concrete is poured. This box is to be removed before the waterproofing is applied. The contractor shall then waterproof the wall and the opening after which the outlet shall be installed. Grout around the box. Boxes to be set carefully so the cover plates will be flush.
- N. Outlet boxes and conduit work which is exposed to the weather, and for vapor-tight lighting fixtures and devices shall be cast corrosion resistant type with threaded conduit hubs to accommodate the conduit size entering.
- O. Outlets for the attachment of lighting fixtures shall be provided with fixture studs securely anchored to the boxes. Where outlet boxes are used to support lighting fixtures, the outlet boxes shall be firmly anchored to the structural members of the building.
- P. Outlets installed in a common wall and are intended to serve each side of the wall shall not be installed back to back but shall be staggered in the wall. Openings in wall common to both sides of walls shall not be acceptable.
- Q. Outlet boxes which serve separate patient rooms but require installation in common walls as in a typical headwall of a patient room, shall be "staggered" with a wall stud separating each. Back to back box installation will not be permitted.
- R. Outlet boxes installed in rated walls shall not exceed 16 square inches unless enclosed by a "5-sided box" or a box with 4 sides and a back.

- S. The aggregate area of all boxes in a rated wall and not enclosed by a "5-sided box" shall not exceed 100 square inches in 100 square feet of wall as measured from floor to structural deck or rated membrane.
- T. Outlet boxes with openings on opposite faces of rated walls shall have a horizontal separation of 24" minimum unless enclosed by a "5-sided box" or a box with 4 sides and a back.

END OF SECTION

**SECTION 16140
WIRING DEVICES****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.
- C. National Fire Protection Association (NFPA) 70 – National Electrical Code (NEC); most recent edition adopted by authority having jurisdiction (AHJ), including all applicable amendments and supplements.
- D. National Electrical Contractors Association NECA 1 – Standard for Good Workmanship in Electrical Construction.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the complete installation of the wiring devices, including all related systems and accessories as shown by the drawings and hereinafter specified.

1.03 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.
- B. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. Switches shall be totally enclosed, rated at 120/277 volts, residential grade, with ivory or white thermoplastic handles or toggles, quiet type, side wired, grounding type full rated at 15 or 20 amperes, unless otherwise noted. Switches shall comply with UL 20 - General-Use Snap Switches; UL 498 - Attachment Plugs and Receptacles and UL 514D - Cover Plates for Flush-Mounted Wiring Devices, current editions, including all revisions, as follows:

SWITCH	LEVITON	PASS & SEYMOUR
Single Pole	2651-2I	TM 885
Double Pole	3032-2I	2622 (20 a)
Three Way	2653-2I	TM 873
Four Way	2654-I	TM 874
Single pole lighted toggle	1201 LHI	TM 870-ON

Devices manufactured by Hubbell, Pass & Seymour, Bryant and Cooper that are equivalent shall be acceptable.

- B. Single and duplex receptacles shall be 15 & 20 ampere, 125 volts, residential grade, side wired, with grounded pole, with ivory or white plastic color, unless noted otherwise. Receptacles shall be NEMA 5 configuration and shall comply with National Electrical Manufacturers Association (NEMA) WD 1 – General Color Requirements for Wiring Devices and WD 6 – Wiring Device – Dimensional Requirements, current editions, including all revisions, as follows:

RECEPTACLE	LEVITON	PASS & SEYMOUR
Duplex	12650-I (15) & 12660-I (20)	TM 885 (15) & 26242 (20)
Single	5821-I (20)	26361
GFCI	6599-I (15) & 6899-I (20)	1594 (15) & 2094 (20)

Devices manufactured by Hubbell, Pass & Seymour, Bryant and Cooper that are equivalent shall be acceptable.

- C. Special purpose receptacles shall be of similar grade specification as single or duplex receptacles and shall be as described in the legend of symbols and notes for electrical systems on the drawings. 30 ampere 5055, 50 ampere 5051
- D. Provide device plates for each and every outlet type, and of the type required for the service and device involved, furnish in gangs as necessary. Plates and screws shall be the product of the same manufacturer. Finish of the plates shall be ivory or white thermoplastic unless otherwise noted. Pass and Seymour TP Series or equivalent.
- E. Where necessary, receptacles shall be furnished with a matching cap.
- F. Prior to installation, the wiring devices shall be stored on the job site in the original labeled cartons. The devices shall be installed in the outlets as soon as possible after the wire is installed. The devices shall then be temporarily covered using the device packaging material, until finishing and painting operations are completed. Devices and device plates that are stained or paint splashed shall be replaced. A cleaned device or device plate will not be accepted.

Time Switches, photocells, contactors, relays shall be provided as specified on the drawings.

- H. Space Smoke Detectors.
1. Provide multiple station wired photoelectric type space smoke detectors in accordance with NFPA 72. The Photoelectric Smoke alarm shall be a hardwired interconnected photoelectric smoke alarm with test switch and Temporal-3 alarm signal or sounder which shall provide the following features and options:
 - a) The device shall have a nominal sensitivity of 2.5% and the alarm shall utilize an infrared LED sensing circuit that pulses in 4 to 5 second intervals. When subjected to smoke the pulse rate shall increase.
 - b) After 2 consecutive pulses in smoke, the detector shall alarm. This alarm shall provide minimum 5-to-1 signal-to-noise ratio in the optics frame to assure stability of operation in environments of high radio frequency (RF) and transient conditions.

- c) The alarm shall have a 9 VDC alkaline battery as a back-up in the event building power is lost. The 9 VDC battery impedance shall be verified by the circuit of the smoke alarm.
 - d) The alarm shall provide an indicator when the battery has low power, high impedance or is missing.
 - e) A solid state piezo alarm rated at 90dBA at a 10-feet distance. A visual LED monitor as a condition indicator will pulse in normal operation and will remain solid in alarm condition.
 - f) The sensing chamber shall be fully screened to prevent entrance of small insects, thus reducing the probability of false alarms.
 - g) An accessible test switch shall be provided. Placing this switch in the TEST position will simulate an actual smoke condition causing the detector to alarm within 20-40 seconds.
 - h) The visual signal shall have a minimal light output of 100 Candela and will flash one time per second.
 - i) TEST switch closure, or smoke generation that does not scatter the light beam or test sensitivity is not sufficient to comply with code. The alarm shall be provided with a Form C contact for remote annunciation. An alarm during this test will also be a maintenance indicator.
2. Provide specialized space smoke detectors consisting of a space smoke detector in compliance with above requirements and containing an integral visual appliance with an effective intensity rating of at least 100 candela and comply with the following requirements:
- a) The device shall be capable of providing monitored battery back-up and shall be UL listed for both wall and ceiling mounting. The detector shall be hardwired photoelectric smoke alarm with an ADA compliant strobe.
 - b) All equipment shall be completely factory assembled, wired and tested. Detectors that do not meet all of the requirements of this specification will not be acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation of wall switches
 - 1. Wall switches shall be installed in the vertical position unless otherwise specified or indicated on the drawings.
 - 2. Vertically operated switches shall be "on" in the upper position, except for 3-way and 4-way switches. If operated horizontally, they shall be "on" in the left position.
 - 3. Where more than one switch is shown at one outlet, they shall be installed under one plate in an order appropriate to the location of the outlets controlled, unless otherwise indicated on drawings.
 - 4. Multiple toggle switches in a single yoke shall not be acceptable.
- B. Connection of Devices
 - 1. All devices shall be side wired. Back wiring shall not be permitted.

2. All devices shall be connected to the neutral conductor by a pigtail, or similar wiring method, so that continuity of the neutral conductor is maintained, even if the device is removed from the circuit
 3. All devices shall have the grounding screws bonded to the outlet box.
 4. Line side terminal taps of ganged switches within ganged outlet boxes for extension to other switches shall not be acceptable.
 5. All exterior mounted GFCI receptacles shall be 20 amp rated 125 VAC.
 6. All kitchen small appliance countertop circuit receptacles and bathroom receptacles shall be GFCI type noted and shall be rated 20 amp, 125 volt AC.
 7. When NM or NMC manufactured cable is utilized, all switch legs shall be marked with purple tape at all outlet boxes.
 8. Device straps shall rest against outlet box extension rings. Use of plaster ears to rest device to drywall shall be unacceptable.
 9. Devices in handicap accessible rooms shall be placed at 44" forward reach in accordance with Florida Building Code Chapter 11 requirements.
 10. Device colors shall be as indicated on interior design drawings.
- C. Smoke Detector System Installation
1. Connect all detectors to mount to 4" square outlet boxes flush in walls.
 2. Provide space detectors with visible strobes only when AHJ requires dwelling units to comply with the Fair Housing Act of 1988 for the purpose of alerting the deaf and hearing impaired in the event of a fire.

END OF SECTION

SECTION 16142
ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section. Section 16010, Supplementary Electrical Conditions, shall apply to the work of this section.
- B. This section is a Division-16 Basic Electrical Materials and Methods section, and is part of each Division-15 and –16 section making reference to electrical connections for equipment specified herein.

1.02 DESCRIPTION OF WORK

- A. The Division 16 Contractor shall provide for final electrical connections to all electrically powered equipment furnished by others, shown on drawings as part of the work. Final electrical connections are hereby defined to include raceways, conductors, and termination materials required for providing electrical power and equipment ground to equipment furnished under this and other divisions.
- B. Refer to Division 15 sections for mechanical equipment and control system wiring and all circuiting less than 120 volt alternating current.
- C. Refer to Specification Section 11400 incorporated by reference only. Where electrical connections to these systems and/or equipment are shown on the construction documents, such work shall be included in the scope of work and coordinated with installation manual. Electrical contractor shall not be responsible for installing any owner furnished equipment.
- D. Fire Pump System
 - 1. An electrically driven fire pump is believed to be required for the building fire sprinkler and standpipe system. Required design criteria are contained on the mechanical construction documents for the successful fire sprinkler contractor to prepare the necessary construction documents, including but not limited to fire pump motor, controller with automatic transfer switch, jockey pump motor controller and all flow and tamper switches.
 - 2. All above components are to be provided and set in place by the fire sprinkler contractor. The Electrical Contractor shall be responsible for making all required line voltage electrical connections to the equipment.
 - 3. Electrical Contractor shall insure the layout of the electrical equipment in the fire pump room is field coordinated with the design of the fire sprinkler contractor and any shop drawings that are prepared. Lack of coordination by the Electrical Contractor shall not relieve him of the responsibility to provide circuiting for the fire pump and accessories in accordance with equipment provided and locations as indicated on the fire sprinkler shop drawings.

PART 2 – PRODUCTS**2.01 MATERIALS AND COMPONENTS**

- A. Raceways
 - 1. Products shall comply with Division-16 basic electrical materials and methods Section 16110. Provide metal raceways and fittings of types grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC and manufacturer's requirements for raceways.
- B. Conductors
 - 1. Provide conductors and connectors complying with Division-16 basic electrical materials and methods Section 16120.
- C. Connectors and Terminals
 - 1. Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications. Where receptacles or connectors are required, coordinate to mate with device provided or equipment supplied.
- D. Electrical Connection Accessories
 - 1. Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.
- E. Disconnecting means:
 - 1. All electrical equipment shall contain a disconnecting means. All disconnecting means not furnished integral with equipment shall be provided and installed by the electrical contractor regardless if they are indicated on the drawings. Comply with Section 16170 requirements.
- F. Motor controllers.
 - 1. All motors shall contain a controller. Where disconnecting means cannot serve as the controller such controllers shall be provided and installed by others. Make all electrical connections to/from the controller.

PART 3 - EXECUTION**3.01 COORDINATION**

- A. Review shop drawings and submittal data with regards to area and conditions under which electrical connections for equipment are to be provided. Manufacturer's installation recommendations are to be reviewed prior to rough-in installation. Where clearances provided do not meet code or installation requirements, written notification shall be provided to the Architect.
- B. The electrical contractor shall be responsible for obtaining the booklet for all Owner furnished equipment. Ignorance on the part of the contractor shall in no way relieve the contractor from responsibility to meet requirements of equipment manufacturer's.

3.02 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Provide electrical connections as indicated; in accordance with equipment manufacturer's written instructions, with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Ringing of copper conductors or cutting of strands is not acceptable.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools.
- D. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.
- E. Provide identification for each disconnect for each piece of equipment served which indicates it's voltage, source, and identification in accordance with Specification Section 16170 whether or not disconnect is provided by Owner.

3.03 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirements.
- B. Electrical contractor shall be required to identify equipment controllers or disconnects regardless if provided by electrical contractor or others.

END OF SECTION

**SECTION 16145
LIGHTING CONTROLS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.
- C. Refer to for Interior Lighting.

1.02 DESCRIPTION OF WORK

- A. Section includes all sensors including multi-technology, ultrasonic, and passive infrared (PIR) technologies. This includes self-contained PIR sensors that are switch-mounted and ceiling-mounted, as well as a low voltage line, which works with a power pack and add-a-relay units. These include:
 - 1. Occupancy sensors
 - 2. Outdoor motion sensors
 - 3. Time switches
 - 4. Interval switches
 - 5. In wall time switches
 - 6. Outdoor photo controls
 - 7. Day-Lighting controls

1.03 RELATED SECTIONS

- A. Related Sections: Section(s) related to this section include:
 - 1. Wiring Methods.
 - 2. Architectural Lighting Controls.
 - 3. Grounding and Bonding.

1.04 REFERENCE STANDARDS

- A. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association.
- F. UL 773 - Plug-in Locking Type Photocontrols for Use with Area Lighting.

**LIGHTING CONTROLS
SECTION 16145-1**

- G. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.
- H. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

1.05 SYSTEM DESCRIPTION

- B. Performance Requirements: Provide lighting controls and power packs that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
- C. Performance Testing Requirements
 - 1. Manufacturer shall 100% test all equipment prior to shipment. Sample testing is not acceptable.
- D. Code Requirements
 - 1. All occupancy sensor lighting controls and power packs shall be UL listed.
 - 2. All sensors shall be FCC compliant where applicable.
 - 3. Building Codes: All units shall comply with applicable, local building codes.

1.06 SUBMITTALS

- A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
- B. Bill of Materials: Complete list of all parts needed to fully install selected occupancy sensors.
- C. Product Data: Submit product data, including catalog cut sheets for specified products.
- E. Shop and Wiring Drawings: Submit shop drawings detailing all mechanical and electrical equipment including one-line diagrams, wire counts, coverage patterns, and physical dimensions of each item.
- F. Fixture Compatibility: List of ballasts and lamp combinations compatible with occupancy sensors, by manufacturer and catalog number.
- G. Installation Instructions: Manufacturer's installation instructions.
- H. Maintenance Instructions: To remove dust and grime, wipe down units with damp cloth and mild detergent solution. Do not touch the surface of the lens.
- I. Closeout Submittals: Warranty documents specified herein.

1.07 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70 – NEC, current approved edition with all revisions and modifications by state and local jurisdictions.
- B. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
- C. Source Limitations: To assure compatibility, obtain occupancy sensors from a single source with complete responsibility over all lighting controls, including accessory products. The use of subcontracted component assemblers is not acceptable.

- D. Manufacturer Requirements: The manufacturer will be one who has been continuously engaged in the manufacture of commercial lighting controls and occupancy sensors for no less than 10 years.
- E. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions, until installation.

1.08 WARRANTY

- A. Manufacturer's Warranty: All equipment shall be warranted free of defects in materials and workmanship.
 - 1. Warranty Period: Five years from date of purchase.
 - 2. Owner Rights: Manufacturer's warranty is in addition to, and not a limitation of, other rights the Owner may have under contract documents.

PART 2 – PRODUCTS

2.01 SELF-CONTAINED UNITS.

- A. Manufacturers:
 - 1. Hubbell Building Automation
 - 2. Sensor Switch
 - 3. WattStopper
 - 4. Leviton Mfg. Company
 - 5. MyTech Corporation
 - 6. Novitas
 - 7. Tork
 - 8. Unenco Electronics, Hubbell Building Automation
 - 9. RAB Lighting
 - 10. Lithonia Lighting.
- B. All Occupancy Sensors
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
 - b. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.
 - 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 - 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.

5. Turn-Off Delay: Field adjustable, up to a maximum time delay setting of not less than 15 minutes and not more than 30 minutes.
6. Compatibility: Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
7. Sensor shall be capable of detecting presence in the control area by detecting changes in the infrared energy.
8. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.
9. Sensor shall utilize technology to optimize automatic time delay to fit occupant usage patterns and shall be selectable with a DIP switch.
10. Sensor shall utilize circuitry on both relays to reduce stress on relays and therefore increase sensor life.
11. Sensor shall utilize two relays capable of simultaneously controlling independent lighting loads or circuits. The secondary relay is isolated, allowing for two-circuit control.
12. Sensor shall have no minimum load requirement and shall be capable of switching from 0 to 800 Watt incandescent; 0 to 800 Watt fluorescent or 1/6 HP @ 120 VAC, 50/60Hz; and 0 to 1200 Watt fluorescent @ 230/277 VAC, 50/60Hz.
13. To blend in aesthetically, sensor shall not protrude more than 1/2" from the wall and utilize color-matched lens.
14. To assure detection at desktop level uniformly across the space, sensor shall have a segmented, dual-level, Fresnel lens.
15. Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by a DIP switch.
16. To avoid false ON activations and to provide immunity to RFI and EMI, processing shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
17. Robotic test method as referred in the NEMA WD 7 guide shall be utilized for minor motion coverage verification.
18. Sensor shall cover up to 1,000 sq. ft. for walking motion, with a field view of 180 degree.
19. Sensor shall have automatic-ON or manual-ON operation on both relays adjustable with DIP switch.
20. Sensor shall have a time delay that is adjusted automatically and shall have an adjustable time delay of 5 to 30 minutes.
21. Sensor shall be capable of automatically returning to Automatic-ON after lights are turned off manually.
22. Sensor shall have the optional audible warning that shall beep to warn the end-user before lights automatically turn off and have an optional visual warning that shall flash lights to warn the end-user before lights automatically turn off.
23. Sensor shall have a LED indicator that remains active at all times and switching mechanism shall be a relay.

- C. Wall Switch with Dual Technology
 - 1. Sensor shall have above features.
 - 2. Sensor shall be able to control incandescent, magnetic low voltage, electronic low voltage, and fluorescent loads.
- D. Ceiling-Mount with Dual Technology
 - 1. Sensor shall have above features.
 - 2. Device shall mount on the ceiling and incorporate a motion indicator LED, visible from the front of unit and feature manual timer settings between 3 and 30 minutes.
 - 3. Infrared lenses shall have 360° field of view and be equipped with tamper resistant cover.
 - 4. All controls shall be accessible from bottom of unit with ratings: 0-1500W @ 120V, 230V or 277V AC.

2.02 LOW VOLTAGE UNITS

- A. Performance
 - 1. Occupancy Sensors shall turn off or reduce lighting automatically after reasonable time delay when a room or area is vacated by the last person to occupy the space.
 - 2. Occupancy sensor shall accommodate all conditions of space utilization and all irregular work hours and habits.
 - 3. Sensors shall be UL listed and utilize dual technology
 - 4. Sensors shall be fully adaptive and adjust their sensitivity and timing to ensure optimal lighting control for any use of the space.
 - 5. Sensors shall have optional readily accessible, user adjustable controls for time delay and sensitivity that can override any adaptive features.
 - 6. Sensors shall Infrared, Ultrasonic or Infrared and Ultrasonic) as its sensing mechanism.
 - 7. Occupancy sensors using ultrasonic technology shall have an operating frequency of 32 KHz or 40 KHz, that shall be crystal controlled to within plus or minus 0.005% tolerance to assure reliable performance and eliminate sensor cross talk. Sensors using multiple frequencies are not acceptable.
 - 9. All sensors shall provide a method of indication to verify that motion is being detected during testing and that the unit is working. There shall be different indicators for Infrared and Ultrasonic technologies and both indicators shall be present on a dual technology sensor.
 - 10. Sensors and power packs shall be UL94V-0 or UL94-5V rated respectively.
 - 11. Controls shall incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and learned parameters saved in protected memory shall not be lost.
 - 12. Controls shall not be susceptible to damage or loss of memory due to static discharge.
 - 13. Controls shall operate in an ambient temperature range of 0°C (32°F) to 40°C (104°F) and less than 90% non-condensing relative humidity.
- B. Ceiling and Wall Mount Sensors
 - 1. Sensor shall be easily mounted to a standard acoustic ceiling tile or surface mounted, and all necessary mounting hardware and instructions shall be provided.

2. Ceiling mount sensors shall have viewing directions indicated on the mounting bracket allowing for ease of installation.
 3. Wall mount sensors shall have a swivel mount base allowing for exact positioning of sensor.
 4. Ceiling-Mount occupancy sensors using passive infrared technology shall have a customizable mask to block off unwanted viewing areas.
 5. Sensors shall be Class 2 devices.
 6. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components to achieve this function are not acceptable.
 7. Sensor shall have the ability to be put into an 8 second test mode to verify correct operation and coverage.
 8. Ceiling mount models shall be:
 - a. LOS-CDT, Dual Technology
 - b. LOS-CIR, Infrared Technology
 - c. LOS-CUS, Ultrasonic Technology
 9. Wall mounted models shall be:
 - a. LOS-WDT, Dual Technology
 - b. LOS-WIR, Infrared Technology
- C. Sensor Power Packs
1. For ease of mounting, installation and future service, power pack(s) shall be able to mount through a 1/2" knock-out in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of three (3) sensors.
 2. Power pack shall be plenum rated.
 3. Control wiring between sensors and control units shall be Class 2, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.
 4. Power packs shall be Lutron Model PP-Voltage.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.
- B. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.02 INSTALLATION

- A. The Contractor shall coordinate, receive, mount, connect, and place into operation all devices and equipment. The Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control and occupancy sensors as described herein and shown on the plans. The Electrical Contractor

shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

1. Compliance: Contractor shall comply with manufacturer's product data, including shop drawings, technical bulletins, product catalog installation instructions, and product carton instructions for installation.
2. Power: Contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.

3.03 TESTING

- A. Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, a qualified factory representative shall completely check the installation prior to energizing the system. Each installed occupancy sensor shall be tested in the test mode to see that lights turn off and on based on occupancy.
- B. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.04 PROTECTION

- A. Contractor shall protect installed product and finished surfaces from damage during all phases of installation including preparation, testing, and cleanup. Devices that are stained, paint splashed or scored shall be replaced as dictated by the Architect.

3.05 IDENTIFICATION

- A. Colors and device plate engraving shall comply with Specification Section 16140, Part 2. Critical branch connected sensors shall be gray with red plates.

END OF SECTION

**SECTION 16155
MOTOR STARTERS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of the motor starters, including all related systems and accessories as shown by the drawings and hereinafter specified.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. In general, motor starters for all mechanical and plumbing equipment will be furnished by the Mechanical and Plumbing Contractors respectively. The Electrical Contractor shall be required to install the motor starters and to furnish and install all electrical power wiring to the starter and equipment. The control wiring to operate the equipment shall be furnished and installed by the contractor furnishing the starter.
- B. Where motor starters to be furnished by the Electrical Contractor are required, motor starters shall be full voltage, across the line magnetic or solid state, electronic motor starters, rated as required for equipment served, with 120 volt coil, hand off automatic selector switch in cover, and general purpose NEMA-1 (indoor) or rain-tight NEMA-3R (outdoor) enclosure or where exposed to wet conditions.
- C. Starters shall be equipped with thermal overloads in each underground conductor. Thermal overloads shall be sized in accordance with nameplate rating of motor supplied. Motor starters shall be manufactured by:
 - 1. General Electric Company.
 - 2. Schneider Electric, Square D Company
 - 3. Eaton Cutler-Hammer
 - 4. Siemens
 - 5. Allen Bradley.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Where required, motor starters shall be securely attached to building construction, using wood screws for wood construction, bolts for metal construction, and expansion anchors with bolts for masonry or concrete construction.

END OF SECTION**MOTOR STARTERS
SECTION 16155 - 1****09/20/2017**

SECTION 16170
MOTOR AND CIRCUIT DISCONNECTS

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included consists of furnishing all material and equipment and performing all labor and services necessary for the installation of the motor and circuit disconnects, including all related systems and accessories as shown by the drawings and hereinafter specified.

1.02 RELATED SECTIONS

- A. Refer to circuit breakers.
- B. Refer to fuses.

PART 2 – PRODUCTS**2.01 MATERIALS**

- A. All motor disconnect switches shall be rated for the voltage (240 VAC or 600 VAC) available in NEMA-1 (indoor) or rain-tight NEMA-3R (outdoor) enclosures, unless noted otherwise. Switches shall be fusible or non-fusible as indicated on the drawings in ratings as required for the equipment served. Motor disconnect switches shall be of the heavy duty type as manufactured by Siemens, Square D Company, Eaton Cutler-Hammer, or General Electric Company.
- B. Any and all fused or unfused safety switches which may be required shall be furnished and installed under this Section of the work. Switches shall be provided with quick-make, quick-break mechanisms and shall be general duty type and of the appropriate ampere rating. Those employed for motors and their feeders shall be horsepower rated switches. Switches for outdoor installation shall be provided with weathertight cabinets. Those utilized for service entrance duty shall bear the UL label of approval for such service.
- C. Circuit breaker switches shall be utilized where specifically noted on the drawings. Provide thermal magnetic or electronic trip type as noted with AIC ratings equivalent to upstream device unless service entrance rated.
- D. Molded case switches shall be utilized when specifically noted on the drawings. Provide suitable model with short circuit withstand as noted on the drawings.

- E. Manual disconnecting means for fractional single phase motors or appliances shall be of the toggle type and shall be rated at 125 percent of motor full load amperes. Switches shall be lockable.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Where required, motor and circuit disconnects shall be securely attached to the building construction, using wood screws for wood construction, bolts for metal construction, and expansion anchors with bolts for masonry or concrete construction.
- B. Motor circuit disconnects furnished and installed by the Electrical Contractor shall not be mounted to mechanical equipment, unless otherwise noted. The motor and circuit disconnects shall be supported by the building structure or by independent supports.
- C. Provide a white finish with black core letters phenolic nameplate with 3/8" engraved letters. Nameplate shall indicate the equipment controlled and associated unit number or physical address

END OF SECTION

**SECTION 16182
CIRCUIT BREAKERS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of the circuit breakers, including all related systems and accessories as shown by the drawings and hereinafter specified.

PART 2 - PRODUCTS

2.01 CIRCUIT BREAKERS

- A. All circuit breakers shall be UL labeled and shall be thermal magnetic or electronic solid state, molded case type, quick-make and quick-break both on manual and on automatic operation and shall be of the plug-on type.
- B. Breakers shall be the over-the-center toggle operating type, with the handle going to a position between "on" and "off" to indicate automatic tripping.
- C. All multi-pole breakers shall be internal common trip. The breakers furnished shall be determined by the specifications, the ampacity and poles, as scheduled or as indicated, and by the minimum UL labeled RMS symmetrical amperes interrupting capacity at circuit voltage, as indicated by the schedules.
- D. Breakers shall not be rated for less than 10,000 RMS symmetrical amperes. NEMA ratings shall not be acceptable in lieu of UL ratings.
- E. Breakers shall be labeled as required by the NEC. All circuit breakers shall be rated for available symmetrical fault at its line side terminals. Series rates circuit breakers shall/shall not be acceptable.
- F. An overcurrent protection device coordination study for all devices to be utilized for this project shall be prepared and provided, as required.
 - 1. Basis of design as indicated in coordination study.
 - 2. The Contractor shall be responsible for providing exact overcurrent protection devices indicated in study. The Contractor may choose to utilize alternative manufacturers of overcurrent devices if a complete coordination study including all overcurrent devices is submitted to the Engineer of Record and is approved as equivalent.
 - 3. Trip and control settings for all adjustable circuit breakers installed shall be set and verified by the contractor according to NECA 700 – Standard for Installing Overcurrent Protection to Achieve Selective Coordination.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install per manufacturer's recommended installation instructions.
- B. All molded case main circuit breakers shall be vertically mounted. All vertically mounted molded case circuit breakers shall be mounted so the handle is up for "on" and down for "off", when viewed from the normal standing position.

END OF SECTION

**SECTION 16190
SUPPORTING DEVICES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of raceway supports including trapeze type supports for multiple raceways.
- B. Section does not include supporting devices such as cable trays, cable supports for any low voltage system or wood backboards. For support required for low voltage systems refer to respective specification system.
- C. Section does not include product for supporting single raceways from structure including but not limited to one and two hole straps, beam clamps and support rods. Such products shall be provided from listed manufacturers as required to meet load capabilities of raceways and conductors.

1.03 REFERENCES

- A. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
- B. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A570)
- C. ASTM F1136 – Standard Specification for Chromium/Zinc Corrosion Protective Coatings for Fasteners
- D. ASTM A907 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled, Structural Quality
- E. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- F. MFMA - Metal Framing Manufactureres Association
- G. ANSI/NFPA 70– National Fire Protection Association (National Electrical Code)

1.04 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of bolted metal framing of the types required, whose products have been in satisfactory use in similar service for not less than 5 years.

**SUPPORTING DEVICES
SECTION 16190-1**

- B. MFMA Compliance: Comply with the latest revision of MFMA Standards Publication Number MFMA-3, "Metal Framing Standards Publication".
- C. NEC Compliance: Comply with the latest revision NFPA 70 - Article 386 "Surface Metal Raceways. Comply with the latest revision for support spacings for all raceway types being supported..
- D. UL Compliance: Comply with UL "Standard for Surface Metal Raceway and Fittings", UL 5.
- E. Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request.

1.05 SUBMITTALS

- A. Submit cross sectional drawings of different strut length and physical dimensions based on spacing distances and accessories including clamps, brackets, hanger rods, and fittings.
- B. Submit manufacturer's product data on strut channels including, but not limited to, types, materials, finishes, gauge thickness, and hole patterns. For each different strut cross-section, submit cross sectional properties including Section Modulus (S_x) and Moment of Inertia (I_x).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver strut systems and components carefully to avoid breakage, denting, and scoring finishes. Do not install damaged equipment.
- B. Store strut systems and components in original cartons and in clean dry space; protect from weather and construction traffic.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with these specifications, strut systems to be installed shall be as manufactured by Cooper B-Line, Inc. T&B (Kindorf) or Unistrut.

2.02 STRUT CHANNELS AND COMPONENTS

- A. General: Strut shall be 1-5/8 inches wide in varying heights and combinations as required to meet load capacities of the raceways and conductors strut is to support.
- B. Materials and Finish: Material and finish specifications for each strut type are as follows:
 - 1. Aluminum: Strut shall be manufactured of extruded aluminum alloy 6063-T6. All fittings and hardware shall be zinc plated according to ASTM B633 (SC3 for fittings, SC1 for threaded hardware) for indoor use only. For outdoor use, all fittings and hardware shall be stainless steel Type 304 [Type 316]. [Fittings shall be hot dip galvanized after fabrication in accordance with ASTM 123 with stainless steel Type 304 [Type 316] or chromium zinc ASTM F1136 Gr. 3.]

2. Epoxy Painted: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS Grade 33, then painted with water born epoxy applied by a cathodic electro-deposition process. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).
3. Pre-galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 SS, Grade 33, and mill galvanized in accordance with coating designation G90. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33. All fittings and hardware shall be zinc plated in accordance with ASTM B633 (SC3 for fittings, SC1 for threaded hardware).
4. Hot-dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel Type 304 [Type 316] or chromium zinc ASTM F1136 Gr. 3. All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.
5. Stainless Steel: All strut, fittings and hardware shall be made of AISI Type 304 stainless steel as indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install strut in accordance with MFMA-102 'Guidelines for the Use of Metal Framing'; in accordance with equipment manufacturer's recommendations, and with recognized industry practices.
- B. All nuts and bolts shall be tightened to the following values:

Bolt Size	Torque (ft-lbs)
1/4 - 20	6
5/16 - 18	11
3/8 - 16	19
1/2 - 13	50

- C. Raceways shall not be supported from cable tray systems or structure via galvanized wire or any "clip-on" or "push-in" supports.
- D. Concealed raceways not supported via trapeze support structures shall be routed as high as possible. Coordinate with other trades.
- E. Internal and external threads of parts that are screwed or bolted together shall be of the same material including coatings and the method of applying coatings. For example, if the threads of bolts or rods are hot dipped galvanized, the nuts must also be galvanized. If they are electro-galvanized, the nuts must also be electro-galvanized. All threads shall be fully engaged. All parts so intended shall be made tight, using tools intended for the purpose.

F. Conduit Hangers and Supports

1. Conduit throughout the project shall be securely and rigidly supported to the building structure in a neat and workman-like manner, and wherever possible, parallel runs of horizontal conduit shall be grouped together on adjustable trapeze hangers. Support spacing shall not exceed (8) feet.
2. Single conduit (2) inches and larger run concealed horizontally shall be supported by suitable beam clamps or conduit hangers with support rod.
3. Multiple runs of conduit shall be grouped together on trapeze hangers where possible. Vertical runs shall be supported by steel riser clamps secured to strut sections spaced at (6) feet (minimum).
4. Single conduit (1 1/2) inches and smaller run concealed above ceiling may be supported directly to the building structure with strap hangers support spacing shall not exceed (8) feet.

3.02 FASTENING

- A. Fasten all materials and equipment with approved devices. Generally fasteners shall be as follows:
1. Wood: fasten to wood with screws except nails may be used on wood partitions for outlet boxes and raceways up to 1" diameter.
 2. Masonry: Fasten to masonry with threaded meal inserts, metal expansion screws, toggle bolts or power-actuated fasteners.
 3. Steel: Fasten to joist with clamps.

END OF SECTION

SECTION 16210
METERING CENTER – 3 PHASE

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. Multi-Metering Center shall be furnished and wall mounted at locations as shown on the drawings.
- B. Metering shall be UL Listed.

1.03 REFERENCES

- A. NEMA AB 1 - Circuit Breakers
- B. Equipment approved by Meter Equipment Group (MEG), consisting of Duke Energy, FPL, Gulf Power, OG&E, and TECO.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Meter unit(s) shall be manufactured by and approved MEG equipment manufacturer.

2.02 ENCLOSURES

- A. NEMA Type 1 as shown on the drawings.
- B. Enclosures shall be constructed of formed and welded, code gauge steel, with a gray baked enamel finish electrodeposited over cleaned galvanized steel.
- C. No device disassembly is to be required before mounting.
- D. All compartments containing unmetered circuits shall be provided w/sealing means.

2.03 INTERIOR CONSTRUCTION

- A. All components shall be factory assembled and all current carrying parts shall be plated bus bars.
- B. All bussing must be complete from the main lugs to the meter socket and to the circuit breaker using Belleville washers at all joints.
- C. All bussing shall be aluminum.
- D. Phase balancing shall be on a per socket basis.

2.04 METER SOCKETS

- A. Meter sockets shall be ring-less, 4-jaw automatic circuit closing type with 5th jaw

provisions for use on 208Y/120 VAC systems.

- B. Sockets shall be rated 225 ampere continuous duty.
- C. Meter socket jaws must be spring reinforced and front removable.

2.05 MAIN CIRCUIT BREAKER MODULE

- A. Line and load side bussed aluminum bus bars and compression lugs in enclosure suitable for overhead or underground feed.
- B. Provide with insulated neutral and equipment ground bar for service entrance rating.
- C. Provide thermal magnetic circuit breaker in accordance with manufacturer's series rating charts.

2.06 BRANCH CIRCUIT BREAKERS

- A. Branch circuit breakers for 125 ampere devices shall be two-pole, plug-on type QOVH for 15 through 125 ampere breakers.
- B. Branch circuit breakers for 150 or 200 ampere devices shall be type QD breakers, UL listed breakers which utilize the 3/4" format. All type QD breakers shall have 10K AIC rating and be available in 1 Pole and 2 Pole common trip versions.
- C. All circuit breakers shall be UL Classified and UL Listed. All breakers shall be supplied with load side connectors suitable for 60/75 degrees C wire and be calibrated for 40 degrees C maximum ambient applications.
- D. Interrupting ratings shall be selected to provide the required current and short circuit current rating as shown on the drawings.

PART 3 - EXECUTION

3.01 METERING EQUIPMENT INSTALLATION

- A. Mount meter modules to Unistrut channel assembly as noted for equipment mounting on the drawings.
- B. Meter sockets shall be labeled in accordance with utility company meter standards.
- C. No metering center shall be installed prior to confirmation of available fault current available at the point of service as defined by the drawings.

3.02 SUBMITTALS

- A. Provide detailed dimensioned elevation drawing for entire meter center.
- B. Provide a site specific single line diagram of service equipment and meter modules.
- C. Provide "MEG" listing of meter sockets to be utilized.
- D. Provide nameplates in accordance with Section 16170 and per Progress Energy of Florida requirements.

END OF SECTION

**METERING CENTER – 3 PHASE
SECTION 16210-2**

09/20/2017

SECTION 16289
SURGE PROTECTION DEVICE (SPD) SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The requirements of the General Conditions, Supplementary Conditions, Division 1 and Drawings apply to all Work herein.
- B. Requirements of the following Division 16 Sections apply to this section:
 - 1. Basic Division 16 Requirements
 - 2. General Division 16 Materials and Methods

1.02 SCOPE

- A. General: Furnish and install a surge protection device (SPD) system connected to selected electrical power distribution equipment as specified, shown, scheduled, and required.
- B. Related Sections: Division 16 Sections contains requirements related to the work of this Section. These may include, but not be limited to, the following sections:
 - 1. Conduit
 - 2. Conductors
 - 3. Outlet Boxes

1.03 QUALITY ASSURANCE

- A. Manufacturers: Unless specifically noted otherwise, the following specification is based on equipment manufactured by Current Technology. Equipment furnished under this specification shall not be acceptable if any part or component of the product is encapsulated in an epoxy resin compound or any other compound of similar form. If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:
 - 1. Thomas & Betts Current Technology.
 - 2. Leviton.
 - 3. Emerson Liebert.
 - 4. Eaton Cutler-Hammer.
 - 5. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.
- B. Codes and Standards:
 - 1. General: The specified High Exposure SPD shall provide effective high-energy transient voltage suppression, surge current division, high frequency attenuation, and line control in specified ANSI/IEEE C62.41 environments.

2. The system shall be connected in parallel with the facility's wiring system. The High Exposure SPD shall be capable of protection in all ten modes and surviving at least 13,000 ANSI/IEEE C62.41 Category "C3" surges without failing or degrading the UL 1449 Surge Suppression Rating by more than 10%.
 3. UL 1449: SPD shall be listed under UL Standard 1449 – Surge Protective Devices, latest edition.
 4. UL 1283: SPD shall also have recognized testing under UL Standard 1283 – Electromagnetic Interference Filter for high frequency tracking filter component.
 5. ANSI/IEEE C62.41: SPD shall comply with IEEE C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - a. General: Provide SPD designed for the designated surge environment, Types 1, 2 or 3.
 - b. Location Category: Categories A or B, as defined by ANSI/IEEE C62.41.
 - c. Exposure Level: Medium – Geographic locations where medium to high lightning activity is expected, significant load switching is anticipated, or both.
 6. Certification: SPD manufacturer shall furnish certified verification test data for waveforms specified herein. Tests shall be performed per ANSI/IEEE C62.45.
 7. IEEE 1100 Emerald Book
 8. NEMA LS 1, with these features:
 - a. Fused single pulse surge current capacity.
 - b. Minimum repetitive surge current capacity.
 - c. All protection modes (ten protection modes achieved using seven discrete modes).
- C. Ratings: Ratings shall be established and verified by UL testing and testing per ANSI/IEEE C62.45. The UL 1449 Voltage Protective Rating (VPR), including fused disconnect, shall be as follows for each mode of protection:
1. 277/480 Grounded Wye, L-N/1200 volts, L-G/1200 volts, N-G/1200 volts, high exposure
 2. 120/208 Grounded Wye, L-N/700 volts, L-G/700 volts, N-G/700 volts, low exposure
- D. Filtration: Maximum attenuation of 54dB, based on 6 inches of lead length outside of the enclosure using Mill Standard 220B.
- E. Test Data: Suppression filter systems shall be UL 1449 listed as surge protective device and UL 1283 listed as an Electromagnetic Interference Filter. Provide both single pulse surge current test data and minimum repetitive surge current test data. Calculated estimates are not acceptable.
- F. Warranty: The SPD system, including labor and materials, shall be free from defects in workmanship and materials, under normal use and service, for a period of 20 years on service entrance equipment and 15 years on all other equipment from the date of acceptance or beneficial occupancy, which ever occurs first. Any equipment or workmanship shown to be defective shall be repaired, replaced or adjusted during normal working hours at no cost to the owner.

PART 2 - PRODUCTS**2.01 SYSTEM DEVICES**

- A. High Exposure Category C3 Service Entrance Locations (Type 1 Locations): Category C3 Service Entrance Location: Provide device that uses dual technology system for surge protection.
- B. Medium Exposure Category A Distribution Locations (Type 2 Locations): Category A Panelboard Locations: Provide Current Technology PX3 Series (panel extensions) or Current Technology CG Series (installed adjacent to panels) or approved equal by Liebert or Leviton.
- C. Status Indicators: SPD shall have LED status indicator for each phase. Indicators shall be field-replaceable and visible on face of SPD enclosure. Lights shall include features which indicate level of degradation of unit protection

2.02 DEVICE CONSTRUCTION

- A. Service Entrance Unit shall consist of an engineered solid-state high performance suppression system utilizing a predetermined number of selenium cells and array of thermally protected voltage dependent metal oxide varistors (MOV's) with similar operating characteristics. To reduce transient current density during surge suppression, service entrance units shall provide at least 3024 square inches of solid-state suppression area. The unit shall also contain a UL 1283 list capacitive filter, using metalized polypropylene elements with self healing characteristics, and providing the filtration levels as detailed above.
- B. Category A locations shall consist of an engineered solid-state high performance suppression system utilizing thermally protected voltage dependent metal oxide varistors (MOV's) with similar operating characteristics. These units shall also contain a UL 1283 listed capacitive filter, using metalized polypropylene elements with self healing characteristics, and providing the filtration levels as detailed above.

PART 3 - EXECUTION**3.01 SUBMITTALS**

- A. Submittals shall include, but not be limited to, the following:
 - 1. U.L. Listing information.
 - 2. Copy of warranty.
 - 3. SPD manufacturer's installation instructions.
 - 4. Factory data sheets on each piece of equipment proposed.
 - 5. System operational description.
 - 6. Complete system bill of material.
 - 7. Independent test lab results of single impulse current test.
 - 8. Additional information as required by Section 20 05 03, Basic Division 20-28 requirements.
- B. Only basic equipment devices have been shown on the contract documents. It is the Contractors responsibility to submit for approval the complete engineered system configuration and layouts showing all devices, wiring, conduit and locations allowed with other required information as specified herein.

3.02 INSTALLATION

- A. General: Install SPD products in accordance with manufacturers written installation instruction and industry standard practice.
- B. Locations: Install SPD products at locations shown on the Drawings and in accordance with the following:
 - 1. SPD shall not be installed inside switchboard, distribution panels, or lighting/power panels.
 - 2. Service main SPD to be connected to the main service, using manufacturer's recommended cable.
 - 3. Service Entrance Main (Type 1): SPD products shall be installed on the line side of the electrical service main overcurrent protection. Connect SPD to the line side lugs of the new service disconnect. All parts replacement shall be possible from the front of the enclosure by opening hinged door or removal of screw-panel cover. SPD shall be installed as a tap using integral fused disconnect switch.
 - 4. Distribution Switchboards and Distribution Panels (Type 2): Parallel connection via feeder breaker. SPD shall be dead front. All module and parts replacement shall be possible from the front of the SPD enclosure.
 - 5. Panelboards (Type 2): Parallel connection via branch circuit breaker. Provide a SPD close-coupled to the panelboard. Mount SPD on wall next to panel and join with conduit nipple.
 - 6. Circuit Breakers (Type 2 Applications): Provide dedicated circuit breaker for the SPD. Breaker shall have an AIC rating greater than or equal to the available fault current of the panel or switchboard. Circuit breaker shall be three-pole, not combined single-pole breakers. Refer to schedules on Drawings for breaker sizes (minimum of 60 amp).
- C. Wiring and Connection Leads:
 - 1. Minimum wire size for leads to connect SPD shall be AWG #2 for High Exposure (Type 2 locations), and AWG #8 for Low Exposure. Wire shall be stranded copper.
 - 2. Keep length of leads as short as possible (recommend 18" or less).
 - 3. Trim and remove excess lead length, rather than coiling in series.
 - 4. Shape leads to minimize loop-geometry. Twist together the full length of all wires needed for connection leads. Separate leads only to make terminal connections.
 - 5. Avoid sharp bends in the connection leads.

3.03 TESTS AND REPORTS

- A. The installing contractor shall functionally test each and every device in the entire system for proper operation and submit test results.
- B. At conclusion of testing, provide a test set to Owner.

END OF SECTION

**SECTION 16420
SERVICE ENTRANCE**

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of the service entrance system, including all related systems and accessories as shown by the drawings and hereinafter specified.
- B. The electrical service shall be 120/208 volts, three phase, four wire, wye connected with grounded neutral as shown on the drawings.
- C. The electrical service shall be 277/480 volts, three phase, four wire, wye connected with grounded neutral as shown on the drawings.
- D. The service entrance shall comply with the requirements of the NEC and the local utility company.

1.03 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.
- B. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. The switchboard sections shall be of the dead front type, completely metal enclosed, self-supporting structure, independent of wall supports of the required number of vertical sections, bolted together to form one rigid switchboard 91 ½" high incorporating switching and protective devices of the number, rating and type noted herein or shown on the drawings with the necessary interconnections, instrumentation and control wiring. Switchboard construction shall be of the universal frame type using die-formed, bolted members. The sides, top and rear shall be covered with removable screw-on plates. Front plates shall be sectionalized and removable. All plates shall be fabricated from code gauge steel. Ventilation openings shall be provided where required. The switchboard shall meet all National Electrical Code requirements for service equipment.
 - 1. The bus shall be tin-plated copper or tin-plated aluminum or sufficient size to qualify for UL label and adequately braced/supported to withstand mechanical

forces exerted during short circuit conditions when directly connected to a power source having the indicated short circuit current. All connections shall be tightly bolted.

2. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished when required. All groups of control wires leaving the switchboard shall be provided with the terminal blocks with suitable numbering strips. All hardware used on conductors shall have a high tensile strength and an anti-corrosive zinc plating.
3. A ground bus and lugs shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
4. The switchboard section shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.
5. A-B-C type bus arrangement, left-to-right, top-to-bottom, and front-to-rear, as viewed from the front, shall be used throughout.
6. Adequate conduit space shall be provided to meet NEC requirements.
7. Each switching and protective device shall be provided with visible means of on-off indication. All terminals shall be of the anti-turn solderless type suitable for copper or aluminum cable of sizes indicated.
8. All exterior and interior steel surfaces of the switchboard shall be properly cleaned prior to the application of Baked on Gray ANSI 16 Enamel. A rust inhibiting phosphatized coating shall be applied as part of the cleaning operation.
9. The switchboard section shall be a minimum of 20 inches deep. All sections of the switchboard shall align so that the back of the complete structure may be placed flush against a wall. Service sections shall be side as well as front accessible.
10. The internal components (switching and protective devices, etc.) shall be removable from the front and shall be panel mounted with the necessary device line and load connections front accessible.
11. The main or horizontal bus shall be braced for short-circuit stresses up to 100,000 RMS amperes. When interconnecting horizontal bus is installed between vertical sections, no portion of the horizontal bus shall extend within 8 inches of the bottom or within 8 inches of the front, inside any vertical panel section of the switchboard structure.
12. Vertical sections shall be completely factory assembled, wired and tested before delivery, and shall conform to UL listing requirements, where applicable and NEC code standards. Individual vertical sections shall be designed for bolting together at installation site with the only electrical connection being the main bus splice plates.
13. Switchboard shall be manufactured by Square D, General Electric, Siemens I-T-E, or Westinghouse.
14. Due to size limitations in the main electrical room, it shall be the Contractor's responsibility to provide equipment equal to the equipment specified dimensionally.
15. Main Circuit Breakers: The main disconnecting devices shall be individually mounted in switchboard. Refer to the drawings for ampere rating for each main and AIC ratings.

16. Branch Devices: The branch devices shall be suitable for use with the service switchboard as described for the sizes as shown on the drawings. The units shall be listed and approved by UL for general service entrance use.
 - a. Branch circuit breakers are to be totally front accessible and front connectable. They shall be mounted in the switchboard to permit installation, maintenance and testing with reaching over any line side bussing. The branch bussing shall be of a "Blow-on" design such that the connections grip the bus bars firmly under heavy fault current conditions. Removal of the branch circuit breakers shall be by the disconnection of the load side cable terminations only. Refer to the drawings for ampere and AIC rating for each branch circuit breaker.
17. The distribution system shall be a fully rated selectively coordinated system, series rated systems will not be reviewed or accepted by this office.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The switchboard section shall be secured to 4" high concrete pad with expansion anchors and bolts.
- B. Provide a white finish, black core bakelite nameplate for each switch in the switchboard section. Nameplates shall be installed in a suitable location and fastened with sheet metal screws.
- C. Submit a protective device coordination study in accordance with the requirements of Specification Section 16182.

END OF SECTION

SECTION 16440
DISTRIBUTION PANELBOARDS

PART 1 - GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. Power Distribution Panelboard - Furnish and install distribution panelboard(s) as specified herein and where shown on the associated schedules and drawings.

1.03 REFERENCES

The panelboard(s) and circuit breaker(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.

- A. NECA 1 – Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association
- B. NEMA PB 1 – Panelboards
- C. NEMA PB 1.1 – Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- D. NEMA AB 1 – Molded Case Circuit Breakers
- E. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- F. UL 50 – Enclosures for Electrical Equipment
- G. UL 67 – Panelboards
- H. UL 98 – Enclosed and Dead-front Switches
- I. UL 489 – Molded-Case Circuit Breakers and Circuit Breaker Enclosures
- J. CSA Standard C22.2 No. 29-M1989 – Panelboards and Enclosed Panelboards
- K. CSA Standard C22.2 No. 5-M91 – Molded Case Circuit Breakers
- L. Federal Specifications (FS) W-P-115C – Type I, Class 1 and Type II, Class 1
- M. Federal Specifications (FS) W-C-375B/Gen – Circuit Breakers, Molded Case, Branch Circuit and Service.
- N. Federal Specifications (FS) W-C-865C – Fusible Switches
- O. NFPA 70 – National Electrical Code (NEC); Most recent edition adopted by Authority Having Jurisdiction (AHJ)
- P. ASTM – American Society of Testing Materials

1.04 SUBMITTAL AND RECORD DOCUMENTATION

- A. Approval documents shall include drawings. Provide in accordance with general requirements of Divisions 1 and 16. Drawings shall contain overall panelboard

DISTRIBUTION PANELBOARDS
SECTION 16440-1

dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown.

- B. Coordination Study in accordance with Section 16182 requirements.

1.05 QUALIFICATIONS

- A. Panelboards shall be manufactured in accordance with standards listed in Paragraph 1.03 - REFERENCES.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Inspect and report concealed damage to carrier within their required time period.
- B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.
- C. Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.07 OPERATIONS AND MAINTENANCE MATERIALS

- A. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.08 WARRANTY

- A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for one (1) year from the date installation is energized.

1.09 RELATED WORK

- A. Section 16182 Circuit Breakers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. General Electric Company; Spectra Series
- B. Eaton Corporation; Cutler-Hammer.
- C. Schneider Electric; Square D.
- D. Siemens.

2.02 CIRCUIT BREAKERS

- A. All circuit breakers shall be UL labeled and shall be thermal magnetic or electronic solid state, molded case type, quick-make and quick-break both on manual and on automatic operation and shall be of the plug-on type.
- B. Breakers shall be the over-the-center toggle operating type, with the handle going to a position between "on" and "off" to indicate automatic tripping.
- C. All multi-pole breakers shall be internal common trip. The breakers furnished shall be

determined by the specifications, the ampacity and poles, as scheduled or as indicated, and by the minimum UL labeled RMS symmetrical amperes interrupting capacity at circuit voltage, as indicated by the schedules.

- D. Breakers shall not be rated for less than 10,000 RMS symmetrical amperes. NEMA ratings shall not be acceptable in lieu of UL ratings.
- E. Breakers shall be labeled as required by the NEC. All circuit breakers shall be rated for available symmetrical fault at its line side terminals. Series rates circuit breakers shall/shall not be acceptable.
- F. An overcurrent protection device coordination study for all devices to be utilized for this project shall be prepared and provided, as required.
 - 1. Basis of design as indicated in coordination study.
 - 2. The Contractor shall be responsible for providing exact overcurrent protection devices indicated in study. The Contractor may choose to utilize alternative manufacturers of overcurrent devices if a complete coordination study including all overcurrent devices is submitted to the Engineer of Record and is approved as equivalent.
 - 3. Trip and control settings for all adjustable circuit breakers installed shall be set and verified by the contractor according to NECA 700 – Standard for Installing Overcurrent Protection to Achieve Selective Coordination.

2.03 POWER DISTRIBUTION PANELBOARDS

- A. Circuit Breaker – General
 - 1. All circuit breakers shall be UL labeled and shall be thermal magnetic or electronic solid state, molded case type, quick-make and quick-break both on manual and on automatic operation and shall be of the plug-on type.
 - 2. Breakers shall be the over-the-center toggle operating type, with the handle going to a position between “on” and “off” to indicate automatic tripping.
 - 3. All multi-pole breakers shall be internal common trip. The breakers furnished shall be determined by the specifications, the ampacity and poles, as scheduled or as indicated, and by the minimum UL labeled RMS symmetrical amperes interrupting capacity at circuit voltage, as indicated by the schedules.
 - 4. Breakers shall not be rated for less than 10,000 RMS symmetrical amperes. NEMA ratings shall not be acceptable in lieu of UL ratings.
 - 5. Breakers shall be labeled as required by the NEC. All circuit breakers shall be rated for available symmetrical fault at its line side terminals. Series rates circuit breakers shall/shall not be acceptable.
 - 6. An overcurrent protection device coordination study for all devices to be utilized for this project shall be prepared and provided, as required.
 - 4. Basis of design as indicated in coordination study.
 - 5. The Contractor shall be responsible for providing exact overcurrent protection devices indicated in study. The Contractor may choose to utilize alternative manufacturers of overcurrent devices if a complete coordination study including all overcurrent devices is submitted to the Engineer of Record and is approved as equivalent.
 - c. Trip and control settings for all adjustable circuit breakers installed shall be set and verified by the contractor according to NECA 700 – Standard for Installing Overcurrent Protection to Achieve Selective Coordination.
- B. Circuit Breaker Distribution Panelboard
 - 1. Interior
 - a. Shall be bolt-on type rated 600 VAC or 250 VDC maximum. Continuous main current ratings as indicated on associated schedules not to exceed 1200 amperes maximum. Panelboard bus current ratings

DISTRIBUTION PANELBOARDS SECTION 16440-3

shall be determined by heat-rise tests conducted in accordance with UL 67.

- b. Provide UL Listed short circuit current ratings (SCCR) as indicated on the associated schedules not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes.
- c. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
- d. The bussing shall be fully rated with sequentially phased branch distribution. Panelboard bussing rated 1,200 amperes shall be aluminum.
- e. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.
- f. Equipment ground bar shall be bonded. Ground bar shall be copper. Solid neutral shall be copper.

2. Molded Case Circuit Breakers - Branches

- a. Common Characteristics
 - 1) Circuit breakers shall be constructed in accordance with the following standards:
UL 489 Federal Specification W-C-375B/GEN
NEMA AB1 CSA 22.2, No. 5-M91
IEC 157-1 BS 4752
 - 2) Circuit breakers shall be constructed using glass reinforced polyester insulating material providing superior dielectric strength. Current-carrying components shall be completely isolated from the handle and the accessory mounting area.
 - 3) Circuit breakers shall have an over-center, trip-free, toggle operating mechanism which will provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.
 - 4) Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
 - 5) Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
 - 6) Breaker faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIR ratings.
 - 7) Circuit breakers shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.
 - 8) Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings. Circuit breakers shall be suitable for mounting and operating in any position.

**DISTRIBUTION PANELBOARDS
SECTION 16440-4**

- 9) Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.
 - (a) Circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Auxiliary Switch, Alarm Switch, Ground Fault Shunt Trip, Electrical Operators, Cylinder Locks, Mechanical Lugs Kits, Compression Lugs Kits, and Handle Accessories.
- b. Thermal Magnetic – Provide as required subject to the following requirements:
 - 1) Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Thermal elements shall be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
 - 2) Two- and three-pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker which allows the user to simultaneously select the desired trip level of all poles.
 - 3) Standard circuit breakers up to 250 amperes at 600 VAC shall be UL Listed with HACR ratings.
- c. Solid State Electronic Trip (True rms sensing) – Provide as required subject to requirements of Section 16182.
 - 1) Circuit breaker trip system shall be a microprocessor-based true RMS sensing. Frame/sensor ampere ratings are indicated on the drawings.
 - 2) The integral trip system shall be self-powered and shall contain electronic components to measure ampacity, time the output from internal current sensors, and initiate automatic tripping action.
 - 3) Circuit breakers shall be UL Listed to carry 80% continuous current and have true RMS sensing.
 - 4) Provide the following time/current profile adjustments to maximize system selective coordination.
 - (a) The continuous ampere rating of the circuit breaker shall be determined by an interchangeable rating plug and tracking adjustments for short time pick-up and instantaneous settings.
 - (b) The continuous ampere rating of the circuit breaker shall be determined by an interchangeable rating plug and separate adjustment for longtime, short time and instantaneous pickup and delay (LSI).
3. Enclosures
 - a. Type 1 Boxes
 - 1) Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvanized and annealed

DISTRIBUTION PANELBOARDS
SECTION 16440-5

- steel will not be acceptable.
- 2) Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.
- 3) Maximum enclosure dimensions shall be 44" wide and 12" deep.
- b. Type 1 Trim Fronts (provide only where noted in schedules)
 - 1) Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.
 - 2) Trim front shall be 1-piece with door. Trim front door shall have rounded corners and edges free of burrs.
 - 3) Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike. Provide two (2) keys with each lock.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards.
- B. Anchor panelboards to structure as indicated on the drawing, and make branch circuit connections.
- C. Coordinate the panelboard bus ratings and circuit breaker coordination rating with the available fault current noted on schedules.

3.02 FIELD QUALITY CONTROL

- A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- B. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.
- C. Set all circuit breakers in accordance with approved circuit breaker coordination study.

3.03 ACCESSORIES

- A. Nameplates
 - 1. Provide a black finish, white core phenolic nameplate for each normal power panelboard with engraved letters 3/8" high.
 - 2. Provide a purple finish, white core phenolic nameplate for each Essential Electrical System (EES) panelboard with engraved letters 3/8" high.
 - 3. Provide an orange finish, white core phenolic nameplate for each Critical Branch panelboard with engraved letters 3/8" high.
 - 4. Provide a yellow finish, white core phenolic nameplate for each Life Safety Branch panelboard with engraved letters 3/8" high.

5. Provide a Green finish, white core phenolic nameplate for each Equipment Branch panelboard with engraved letters 3/8" high.
6. Provide a blue finish, white core phenolic nameplate for each legally required system panelboard with engraved letters 3/8" high.
7. Nameplates shall be installed centered above trim doors and fastened with sheet metal screws. Nameplate shall state panel designation, voltage, phase, wire and where fed from.

Example #1:

Panel B

208/120V, 3ph. 4 W

Fed from MDP

Example #2:

Panel EP1

208/120V, 3ph. 4 W

Fed from DP1

- B. Identify circuit breakers via nameplates where fronts are not installed. Provide in accordance with other sections.

END OF SECTION

**SECTION 16441
LOAD CENTERS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. Load centers to be furnished and installed at locations as shown on the drawings. Load centers shall be of the type approved, indicated, and specified herein.

1.03 SUBMITTALS

- A. Suppliers shall provide data on arrangement of circuit breakers in each load center. Circuit breakers to be utilized, bus ratings and materials, dimensional drawings of enclosures with circuit breaker mounting provisions.

1.04 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- B. NEMA PB 1 - Panelboards
- C. NEMA PB 1.1 - General Instruction for Safe Installation, Operation and Maintenance Of Panelboards Rated 600 Volts Or Less
- D. Federal Specification W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.
- E. Federal Specifications W-C-375B - Molded Case Circuit Breakers
- F. Federal Specifications W-P115C - Type 1 Class 2 Load Center.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Siemens.
- B. General Electric Company.
- C. Eaton Corporation; Cutler-Hammer Products.
- D. Schneider Electric; Square D Products.

2.02 ENCLOSURES

- A. NEMA PB1: Type 1 as shown on the drawings.

- B. Enclosure shall be fabricated of cold rolled steel for NEMA 1 and galvanized and annealed steel or equivalent rust-resistant steel for location of installation.
- C. Indoor Type I enclosures shall have a flush front, with finish of gray baked enamel.
- D. A laminated directory label shall be provided with circuits identified via typeset as indicated on the schedule.
- E. Mounting shall be as indicated on the drawings.

2.03 INTERIORS

- A. NEMA PB1: Type 1 as shown on the drawings.
- B. Bus bar connections to the branch circuit breakers shall be the distributed phase type and shall accept plug-on circuit breakers.
- C. Short Circuit Current Ratings: 65,000 ampere series ratings shall be provided per the schedule. This rating shall be established by manufacturer testing of a representative load center with main and branch circuit breakers installed.
- D. Provide with equipment ground bar with lugs bonded to enclosure.

2.04 SHORT CIRCUIT CURRENT RATINGS

- A. NEMA AB 1 Federal Specification W-C-375
- B. Circuit breakers shall be Square D type QO plug-on thermal magnetic trip, with an integral crossbar to ensure simultaneous opening of all poles in multi-pole circuit breakers.
- C. Circuit breakers shall have an over-center, trip free, toggle-type operating mechanism with quick-make, quick-break action and positive handle indication.
- D. Handles shall have ON, OFF, and "Tripped" positions. In addition, trip indication shall include a VISI-TRIP indicator appearing in the window of the circuit breaker case (through 125 amperes).
- E. Circuit breakers shall be UL Listed in accordance with UL standard 489 with current ratings as noted on the plans. Interrupting ratings shall be selected to provide the required load center short circuit current rating.
- F. Single-pole, 15 and 20 ampere circuit breakers intended to switch fluorescent lighting loads on a regular basis shall have the SWD marking.
- G. Two -pole circuit breakers 15-60 amperes intended for use with air conditioning, heating, and refrigeration equipment having motor group combinations and marked as such shall have the HACR marking.
- H. Provide UL Class A ground fault interrupter circuit breakers where scheduled on drawings.

- I. The following special application circuit breakers or circuit breaker accessories shall be provided where shown on the drawings:
 1. Circuit breakers with ARC fault interrupting capabilities.
 2. Circuit breakers with GFIC interrupting capabilities.

PART 3 - EXECUTION

3.01 CIRCUIT BREAKERS

- A. Circuit breakers shall be rated for the available fault current at the line lugs or main circuit breaker.
- B. Circuit breakers shall not be "twin" or "piggyback" mounted in space provisions.
- C. All circuit breakers shall be UL labeled and shall be thermal magnetic or electronic solid state, molded case type, quick-make and quick-break both on manual and on automatic operation and shall be of the plug-on type.
- D. All multi-pole breakers shall be internal common trip. The breakers furnished shall be determined by the specifications, the ampacity and poles, as scheduled or as indicated, and by the minimum UL labeled RMS symmetrical amperes interrupting capacity at circuit voltage, as indicated by the schedules.
- E. Breakers shall not be rated for less than 10,000 RMS symmetrical amperes. NEMA ratings shall not be acceptable in lieu of UL ratings.
- F. Breakers shall be labeled as required by the NEC. All circuit breakers shall be rated for available symmetrical fault at its line side terminals. Series rates circuit breakers shall/shall not be acceptable.

END OF SECTION

**SECTION 16442
SWITCHBOARDS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Switchboards.
- B. Switchboard accessories.

1.02 RELATED REQUIREMENTS

- A. Cast-in-Place Concrete: Concrete for supporting foundations and pads.
- B. Grounding and Bonding.
- C. Fuses.

1.03 REFERENCE STANDARDS

- A. ANSI C12.1 - American National Standard Code for Electricity Metering; 2008.
- B. ANSI C39.1 - American National Standard Requirements for Electrical Analog Indicating Instruments; 1981 (R1992).
- C. IEC 60051-1 - Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories - Part 1: Definitions and General Requirements Common To All Parts;; 1997.
- D. IEC 60051-2 - Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories - Part 2: Special Requirements for Ammeters and Voltmeters; 1984.
- E. IEEE C12.1 - American National Standard Code for Electricity Metering; Institute of Electrical and Electronic Engineers; 1988.
- F. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; Institute of Electrical and Electronic Engineers; 2008.
- G. NECA 400 - Standard for Installing and Maintaining Switchboards (ANSI); National Electrical Contractors Association; 2007.
- H. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2001 (R2006).
- I. NEMA PB 2 – Dead front Distribution Switchboards; National Electrical Manufacturers Association; 2006.
- J. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Dead front Distribution Switchboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007.
- K. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.

- L. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Administrative Requirements, for submittal procedures.
- B. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer.
- B. General Electric Company.
- C. Schneider Electric; Square D.
- D. Siemens.

2.02 SWITCHBOARDS

- A. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.
- B. Ratings:
 - 1. Voltage: Rating as shown on one-line diagrams included on the Drawings volts.
 - 2. Configuration: Three phase, four wire, grounded.
 - 3. Main Bus: Rating as shown on one-line diagrams included on the Drawings.

- 4. Integrated Equipment Rating: Rating as shown on one-line diagrams included on the Drawings in RMS amperes symmetrical.
- C. Main Section Devices: Panel mounted.
- D. Distribution Section Devices: Panel mounted.
- E. Bus Material: Copper or tin-plated copper, standard size.
- F. Bus Connections: Bolted, accessible from front for maintenance.
- G. Ground Bus: Extend length of switchboard.
- H. Molded Case Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole.
 - 1. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
 - 2. Provide shunt trip where indicated.
- I. Pull Section:
- J. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.
- K. Enclosure: Type 1 – General Purpose, unless noted or indicated otherwise.
 - 1. Align sections at front and rear.
 - 2. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.03 CIRCUIT BREAKERS

- A. All circuit breakers shall be UL labeled and shall be thermal magnetic or electronic solid state, molded case type, quick-make and quick-break both on manual and on automatic operation and shall be of the plug-on type.
- B. Breakers shall be the over-the-center toggle operating type, with the handle going to a position between "on" and "off" to indicate automatic tripping.
- C. All multi-pole breakers shall be internal common trip. The breakers furnished shall be determined by the specifications, the ampacity and poles, as scheduled or as indicated, and by the minimum UL labeled RMS symmetrical amperes interrupting capacity at circuit voltage, as indicated by the schedules.
- D. Breakers shall not be rated for less than 10,000 RMS symmetrical amperes. NEMA ratings shall not be acceptable in lieu of UL ratings.
- E. Breakers shall be labeled as required by the NEC. All circuit breakers shall be rated for available symmetrical fault at its line side terminals. Series rates circuit breakers shall/shall not be acceptable.
- F. An overcurrent protection device coordination study for all devices to be utilized for this project shall be prepared and provided, as required.
 - 1. Basis of design as indicated in coordination study.
 - 2. The Contractor shall be responsible for providing exact overcurrent protection devices indicated in study. The Contractor may choose to utilize alternative manufacturers of overcurrent devices if a complete coordination study including all overcurrent devices is submitted to the Engineer of Record and is approved

- as equivalent.
3. Trip and control settings for all adjustable circuit breakers installed shall be set and verified by the contractor according to NECA 700 – Standard for Installing Overcurrent Protection to Achieve Selective Coordination.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Install switchboard in locations shown on drawings, according to NEMA PB 2.1.
- B. Install in a neat and workmanlike manner, as specified in NECA 400.
- C. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

END OF SECTION

**SECTION 16443
PANELBOARDS****PART 1 – GENERAL****1.01 SECTION INCLUDES**

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Load centers.
- D. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Grounding and Bonding for Electrical Systems.
- B. Hangers and Supports for Electrical Systems.
- C. Identification for Electrical Systems: Identification products and requirements.
- D. Fuses for fusible switches and spare fuse cabinets.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; 2011 Edition, Including All Applicable Amendments and Supplements.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 67 - Panelboards; Current Edition, Including All Revisions.
- K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

- L. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- M. NEMA AB 1 - Molded Case Circuit Breakers.

1.04 SUBMITTALS

- A. See Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
- C. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70 (NEC).
- B. American Society of Testing Materials (ASTM).

1.06 MAINTENANCE MATERIALS

- A. Furnish two (2) of each panelboard key.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Siemens.
- B. General Electric Company.
- C. Eaton Corporation; Cutler-Hammer Products.
- D. Schneider Electric; Square D Products.

2.02 MATERIALS

- A. Panelboards shall be of the dead-front type incorporating switching and protective device of the number, rating and type specified herein or shown on the drawings. Panelboards shall also comply with NEMA standard for panelboards, ASTM, and the National Electric Code (NEC).
- B. Panelboards shall have general purpose enclosures and shall be suitable for flush or surface mounting, as indicated. Where panelboards are to be used as service entrance equipment, they shall be so labeled.
- C. Panelboards shall be rated for the intended voltage and shall be manufactured in accordance with the Underwriter's Laboratories, Inc. "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where required.
- D. Panelboard Interiors
 - 1. All interiors shall be completely factory assembled with switching and protective devices, wire connectors, etc. All wire connectors, except screw

terminals, shall be of the anti-turn solderless type and all shall be suitable for copper or aluminum wire of the sizes indicated on the drawings.

2. Interiors shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.
3. Bus bars for the mains shall be of tin-plated copper or tin-plated aluminum, sized in accordance with UL Standards. Full size insulated neutral and ground bus bars shall be provided, unless otherwise noted. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Bracing shall be equivalent to the rated interrupting capacity of the smallest overcurrent device in that panelboard.
4. Phase bussing shall be full height without reduction. Cross connectors shall be tin-plated copper or tin-plated aluminum.
5. Insulated neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection or shall utilize set screws to bond the neutral wire to the neutral bus through holes drilled in the neutral bar. A neutral bus utilizing flat head screws to hold the neutral wires will be acceptable provided that ring type crimp-on connectors are used on the conductors that are to be connected to the neutral bus. A ground bus, identical to the neutral bus, shall be provided and bolted to the interior.
6. All molded case main circuit breakers shall be vertically mounted, All vertically mounted molded case circuit breakers shall be mounted so the handle is up for "on" and down for "off", when viewed from the normal standing position.
7. Spaces for installation of future molded case circuit breakers in the field shall be permitted to utilize manufacturer's standard panelboard design. These spaces shall be complete with all bus and bus connectors such that future breakers can be installed without adding or changing the main bus. Bus connectors connected to the energized main bus shall be rigidly anchored at the other end with insulating bus supports or spare breakers.
8. Provide a nameplate listing panel type, number of protective and switching devices and ratings.

E. Panelboard Cabinets or Boxes

1. Boxes or cabinets shall be made from unpainted galvanized steel having multiple knockouts. Provide at least four (4) interior mounting studs for the box.
2. Boxes shall be sufficient size to provide a minimum gutter space of four (4) inches on all sides, and to have a minimum width of twenty inches, unless noted otherwise. Where feeder cables supplying the mains of a panel are carried through the box to supply other electrical equipment (feed-thru), the box shall be sized to include this wiring space. This wiring space shall be in addition to the minimum gutter space specified above.

F. Panelboard Trims

1. Trim shall be fabricated Hinged doors shall cover all switching devices, and shall not uncover any live parts in making switching device handles readily accessible.

2. Doors shall have semi-flush type cylinder lock and catch, except that doors over 48 inches in height shall have a vault handle and catch, complete with lock, arranged to fasten door at top and bottom, as a minimum. All locks shall be keyed alike. Door hinges shall be concealed. Provide a directory frame and card that identifies all spaces with a transparent plastic cover and located in a pocket on the inside face of each door.
3. Trims shall have the same width and height as the box and shall be capable of being mounted using a screwdriver, without other special tools.
4. All exterior and interior steel surfaces of the panelboard trim shall be properly cleaned and finished with grey ANSI 61 paint over a rust-inhibiting coating. Shop drawings shall show these requirements.

2.03 CIRCUIT BREAKERS

- A. All circuit breakers shall be UL labeled and shall be thermal magnetic or electronic solid state, molded case type, quick-make and quick-break both on manual and on automatic operation and shall be of the plug-on type.
- B. Breakers shall be the over-the-center toggle operating type, with the handle going to a position between "on" and "off" to indicate automatic tripping.
- C. All multi-pole breakers shall be internal common trip. The breakers furnished shall be determined by the specifications, the ampacity and poles, as scheduled or as indicated, and by the minimum UL labeled RMS symmetrical amperes interrupting capacity at circuit voltage, as indicated by the schedules.
- D. Breakers shall not be rated for less than 10,000 RMS symmetrical amperes. NEMA ratings shall not be acceptable in lieu of UL ratings.
- E. Breakers shall be labeled as required by the NEC. All circuit breakers shall be rated for available symmetrical fault at its line side terminals. Series rates circuit breakers shall/shall not be acceptable.
- F. An overcurrent protection device coordination study for all devices to be utilized for this project shall be prepared and provided, as required.
 1. Basis of design as indicated in coordination study.
 2. The Contractor shall be responsible for providing exact overcurrent protection devices indicated in study. The Contractor may choose to utilize alternative manufacturers of overcurrent devices if a complete coordination study including all overcurrent devices is submitted to the Engineer of Record and is approved as equivalent.
 3. Trip and control settings for all adjustable circuit breakers installed shall be set and verified by the contractor according to NECA 700 – Standard for Installing Overcurrent Protection to Achieve Selective Coordination.

2.04 ALL PANELBOARDS

- A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 1. Altitude: Less than 6,600 feet (2,000 m).

- 2. Ambient Temperature: Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
- C. Short Circuit Current Rating: As shown on drawings.
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.05 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum.
 - 2. Ground Bus Material: Aluminum.
- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.

- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
- F. Description: NEMA PB 1, circuit breaker type.
- G. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.
- H. Minimum integrated short circuit rating: As indicated.
- I. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.
- J. Enclosure: NEMA PB 1, Type 1, cabinet box.
- K. Cabinet Front: Surface type, door-in-door, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

2.06 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Aluminum.
 - 3. Ground Bus Material: Aluminum.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Provide clear plastic circuit directory holder mounted on inside of door.
- F. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.
- G. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.
 - 1. Neutral bus shall be rated at 100% capacity and shall be mounted on insulated supports.

- H. Minimum Integrated Short Circuit Rating: As indicated on drawings.
- I. Enclosure: NEMA PB 1, Type 1.
- J. Cabinet Box: 6 inches (153 mm) deep, 20 inches (508 mm) wide for 240 volt and less panelboards, 20 inches (508 mm) wide for 480 volt panelboards.
- K. Cabinet Front, with the following features:
 - 1. Flush cabinet front with concealed trim clamps or attachments.
 - 2. Concealed hinge, metal directory frame, and flush lock all keyed alike.
 - 3. Provide door-in-door cabinet type for panelboards rated at 800 amps or higher.
 - 4. Finish in manufacturer's standard gray enamel.

2.06 LOAD CENTERS

- A. Description: Circuit breaker type load centers listed and labeled as complying with UL 67; ratings, configurations, and features as indicated on the drawings.
- B. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Bus Material: Aluminum or copper.
- C. Circuit Breakers: Thermal magnetic plug-in type.
- D. Enclosures:
 - 1. Provide flush-mounted enclosures unless otherwise indicated.
 - 2. Provide circuit directory label on inside of door or individual circuit labels adjacent to circuit breakers.

2.08 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than: 10,000 amps symmetrical.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - 3. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports, as required.
- E. Install panelboards plumb and level.
- F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and with rough openings completely covered.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.
- H. Provide minimum of six spare 1 inch (27 mm) trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- I. Provide grounding and bonding, as required.
- J. Install all field-installed branch devices, components, and accessories.
- K. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.
- L. Install recessed panelboards flush with wall finishes.
- M. Provide filler plates to cover unused spaces in panelboards.
- N. Provide a typewritten or computer-generated circuit directory for each panelboard and each power distribution panelboard. Directory shall clearly and specifically indicate the type of loads served and the location, space, area or room served. Identify spares and spaces.
- O. Neatly fill in circuit labels for each load center, clearly and specifically indicating the loads and rooms served. Identify spares and spaces.
- P. Provide identification nameplate for each panelboard, as required.
- Q. Provide arc flash warning labels in accordance with NFPA 70.
- R. Provide spare conduits out of each recessed panelboard to a location above an accessible ceiling. Identify each as SPARE.
- S. Ground and bond panelboard enclosure, as required. In healthcare facilities, provide a minimum #10 conductor with a green color coating to bond each panelboard serving any spaces located in these areas.

- T. Where circuit breakers are being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify and replace the old directory with the new one.

3.01 ACCESSORIES

- A. Provide a black finish, white core phenolic nameplate for each normal power panelboard with engraved letters 3/8" high.
- B. Provide a purple finish, white core phenolic nameplate for each Essential Electrical System (EES) panelboard with engraved letters 3/8" high.
- C. Provide an orange finish, white core phenolic nameplate for each Critical Branch panelboard with engraved letters 3/8" high.
- D. Provide a yellow finish, white core phenolic nameplate for each Life Safety Branch panelboard with engraved letters 3/8" high.
- E. Provide a Green finish, white core phenolic nameplate for each Equipment Branch panelboard with engraved letters 3/8" high.
- F. Provide a blue finish, white core phenolic nameplate for each legally required system panelboard with engraved letters 3/8" high.
- G. Nameplates shall be installed centered above trim doors and fastened with sheet metal screws and shall state panel designation or name, voltage, phase, number of wires and where fed from.

END OF SECTION

**SECTION 16450
GROUNDING****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary to insure that the electrical service and electrical systems conform with the requirements of Article 250 of the NEC and as specified hereinafter.

PART 2 - PRODUCTS**2.01 MATERIALS**

- A. The products specified in Section 16120 apply to the work specified in this Section.
- B. Ground rods shall be a minimum of 5/8" x 10'-0" Copper-clad ground rods.
- C. Ground clamps shall be UL approved for the application.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. The following systems and/or equipment shall be grounded in accordance with the rules of the National Electrical Code, the local code and as hereinafter specified.
 - 1. Building Power System
 - 2. Raceway and Conduit Systems
 - 3. Lighting Fixtures
 - 4. Non-current Carrying Metal Parts of all Motors, Panels and Other Electrically Operated Equipment.
 - 5. Telephone System
 - 6. Fire Alarm System
 - 7. Each above Ground Gas Piping System Upstream from the Equipment Shutoff Valve.
- B. The service equipment shall be bonded ahead of the main water service meter and grounded to installed ground rods using bare copper wire in steel conduit bonded at both ends. The wire shall be sized in accordance with Article 250-94 of the NEC. Copper-clad ground rods shall be driven to a depth sufficient to provide a grounding electrode of 25 ohms maximum resistance to ground. If the resistance is greater than 25 ohms, additional ground rods shall be installed and bonded to the first electrode.

- C. Made electrodes shall consist of (2) copper ground rods. The rods shall be installed such that at least 8'-0" of length is in contact with the soil. The upper end of the electrode shall be flush with or below ground level unless the above ground end and the grounding wire attachment are protected against physical damage.
- D. All metallic conduits entering the building service panel shall be bonded together and to the system service ground. Metallic conduit systems shall be electrically continuous throughout.
- E. The system neutral conductor shall be identified throughout and shall be grounded at the building service only.
- F. An equipment grounding wire sized as per NEC shall be installed inside all conduit, and shall have green insulation.
- G. All grounding electrode connections shall be accessible for periodic inspection and testing.
- H. Isolated ground systems shall have a separate ground wire installed in the conduit which is run to the building service ground with no other interconnections between normal ground and isolated ground. Isolated ground wires shall be sized in accordance with the equipment served and shall be identified by a colored stripe on the green insulation.
 - 1. Isolated ground systems shall have a separate ground wire installed in the conduit which is run to the building service ground with no other interconnections between normal ground and isolated ground. Isolated ground wires shall be sized in accordance with the equipment served and shall be identified by a colored stripe on the green insulation.
- I. Grounding of all system equipment including, fire alarm, telephone and cable T.V. shall include bonding of the required system grounding electrode with the building service main grounding electrode at the service entrance. Minimum size bonding conductor shall be #6 AWG copper. Bonding together of all separate electrodes shall be permitted.
- J. Equipotential Grounding
 - 1. Equipotential grounding shall be conducted in all patient care areas. This test shall include metal conductive surfaces likely to become energized when contacted by patient or attendant touching the patient within the patient vicinity, example: beds, headwall, a/c units, sink trim, etc.
 - 2. Test Method
 - a. Both voltage and impedance measurements must be made.
 - b. A reference point in or near the area being tested must be made before measurements are taken. A suitable reference point shall be one of the following:
 - 1) Ground bar in a panel serving the area.
 - 2) Established ground bus.
 - 3) An all-metal cold water pipe.
 - 4) Grounding contact or a receptacle that is powered from a different circuit from the receptacle under test.
 - c. Voltage measurements shall be made between the reference point and appropriate conductive surfaces including receptacle ground contacts.
 - d. Impedance measurements are to be made only between reference point and receptacle ground contacts.
 - 3. Testing instrument utilized shall have a calibration date which is less than 1 year old, as of date of testing.

**SECTION 16501
LAMPS, DRIVERS AND BALLASTS**

PART 1 – GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of the lamps, including all related systems and accessories as shown on the drawings and hereinafter specified.
- B. Definitions:
 - 1. BF: Ballast factor is the ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
 - 2. CRI: Color rendering index is a measure of the ability of a light source to reproduce the colors of various objects being lit by the source. It is measured by comparing the color rendering of the test source to that of a black body radiator source, such as an incandescent lamp. CRI measurements range from 0 to 100, where 100 is the best color rendition. For example, an incandescent lamp will have a CRI of 100 and some tri-phosphor fluorescent lamps may have a CRI of 80 to 90.
 - 3. Color Temperature and Correlated Color Temperature: Related to CRI is the color temperature of the lamp, expressed in degrees Kelvin (K). The color temperature of a light source is determined by comparing its chromaticity with a theoretical, heated black-body radiator. The temperature at which the heated black-body radiator matches the color of the light source is the color temperature of that source. Many light sources, such as fluorescent lamps, do not emit light because of the temperature of the source and the emitted radiation does not follow the form of a black-body spectrum and is assigned a correlated color temperature (CCT). For example, a fluorescent lamp may be specified with a correlated color temperature of 3500 K.
 - 4. CU: Coefficient of utilization is a measure of the efficiency of a luminaire (lighting fixture) in transferring luminous energy to the working plane in a particular area. It is the ratio of lumens from a luminaire incident upon a work plane relative to the lumens emitted by the lamps within the luminaire and measures the light actually reaching the desired plane as a percentage of the total light produced by the fixture.
 - 5. Luminaire: Complete lighting fixture, including ballast or driver housing, if provided.
 - 6. LER: Luminaire efficiency rating calculated according to NEMA LE-5 or estimated from photometric data using the following formula: LER is equal to the product of rated lamp lumens times BF times luminaire efficiency, divided by input watts.

7. RCR: Room cavity ratio is calculated as 2.5 times the room cavity depth (RCD) times the perimeter of the room divided by the area of the room. The room cavity depth is the depth, in feet, from the luminaire (lighting fixture) to the work-plane.
- C. Extra Materials
1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 2. Lamps: One (1) for every 10 of each type and rating installed. Furnish at least one of each type.
 3. Plastic Diffusers and Lenses: One (1) for every 100 of each type and rating installed. Furnish at least one of each type.
 4. Battery and Charger: One (1) for each emergency lighting unit.
 5. Ballasts: One (1) for every 100 of each type and rating installed. Furnish at least one of each type.
 6. Globes and Guards: One (1) for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 – PRODUCTS

2.01 LAMP MANUFACTURERS

- A. OSRAM Sylvania.
- B. Philips Lighting Co of NA.
- C. GE Lighting.
- D. Westinghouse Electric Corporation.
- E. Cree LED Lighting.
- F. Hitachi Lighting

2.02 BALLAST AND DRIVER MANUFACTURERS

- A. Philips Advance
- B. Universal Lighting Technologies (ULT)
- C. Philips Bodine
- D. Prescolite
- E. Osram-Motorola
- F. Lightolier
- G. GE Lighting
- H. Lutron
- I. LED Dynamics
- J. Microchip
- K. Diodes Incorporated
- L. Texas Instruments

2.03 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70 and NFPA 101.
- B. Color temperature requirement shall be as indicated on the drawings
- C. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc
- G. All high intensity discharge lamp luminaire ballasts shall be constant wattage high power factory type, unless noted otherwise.
- H. Low-Mercury lamps shall comply with Federal toxic characteristic leaching procedure (TCLP) test and yield less than 0.2 milligrams per liter (mg/l) of mercury, when tested according to NEMA LL 1. All lamps shall have green end caps to show compliance with all applicable EPA rules and regulations.
- I. Fluorescent lamps shall be programmed start, and or pre-heat as applicable, with a minimum rated life of 20,000 hours at three (3) hours per start, unless indicated otherwise.
- J. Fluorescent lamps shall be energy saving pre-heat, T-8, programmed start, with a minimum rated life of 20,000 hours at three (3) hours per start unless indicated otherwise.
 - 1. T8 programmed-start and rapid-start low-mercury lamps shall have a minimum CRI of 82 with an average rated life of 20,000 hours, unless otherwise indicated.
 - 2. T5 programmed-start low-mercury lamps shall have a minimum CRI of 85 with an average rated life of 20,000 hours, unless otherwise indicated.
 - 3. Compact fluorescent lamps shall have a minimum CRI 80 with an average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.
 - 4. Color temperature for all fluorescent lamps shall be 2700 K, unless indicated otherwise in the Fixture Schedule or elsewhere on the Drawings.
- K. Incandescent lamps shall be inside frosted, unless otherwise noted, with a minimum rated life of 1,000 hours, and rated for 120 volt operation.
- L. Metal Halide lamps shall have a minimum rated life of 20,000 hours, and shall be operated through a ballast designed to the lamp wattage and supply voltage indicated on the plans.

- M. Twin tube fluorescent lamps shall have a minimum rated life of 10,000 hours and shall be operated through a ballast designed to the lamp wattage and supply voltage indicated on the plans. Lamps shall have single ended 4 pin base.
- N. LED fixtures shall be constructed to permit separate replacement of driver and lamp modules.
- O. LED manufacturer shall stock LED lamps from same lot as provided to ensure color matching of replacement lamps.
- P. Lumen maintenance for LED fixtures shall be certified for LM-79, LM080 and TM-21. Provide statement of test compliance from nationally recognized testing laboratory (NRTL).
- Q. Provide a minimum five (5) year warranty on entire LED fixture, including lamps, drivers and other components.
- R. Color rendering index (CRI) per IES LM-79 and Correlated color temperature (CCT) per IES LM-79 and ANSI/NEMA/ANSI C78.377, *Specification for the Chromaticity of Solid-State Lighting (SSL) Products*:
 - 1. CRI equal to 90 or better,
 - 2. CCT equal to 2700 °K for general lighting and down-lighting,
 - 3. CCT equivalent to 3000 °K for accent and display lighting, and special purpose lighting.
- S. Minimum LED luminaire efficacy per IES LM-79, *Approved Method: Electrical and Photometric Measurement of Solid-State Lighting Products*:
 - 1. 90 lumens/watt for general lighting,
 - 2. 50 lumens/watt for accent and display lighting, down-lighting, and special purpose lighting.

2.04 BALLASTS AND DRIVERS

- A. Provide ballasts containing no polychlorinated biphenyls (PCBs).
- B. Minimum Efficiency/Efficacy: Provide ballasts complying with all current and applicable federal and state ballast efficiency/efficacy standards.
- C. Electronic ballast operating frequency shall be 20 KHz or higher. Lamp end-of-life detection and shutdown circuit, when electronic ballast is provided.
- D. Dimming range for fluorescent fixtures controlled by dimmers shall be 5 to 100 percent of rated lamp lumens.
- E. Fluorescent ballasts: Electronic
 - 1. Efficiency: 80 percent, as minimum.
 - 2. Power Factor: 70, or better.
 - 3. Starting Method: Programmed.
 - 4. Properties: Anti-striation Control and Universal Voltage.
- F. Compact Fluorescent Ballasts: Electronic
 - 1. Efficiency: 80 percent, as minimum.
 - 2. Power Factor: 70, or better.

3. Starting Method: Preheat or programmed.
 4. Properties: Auto-restart and Thermally Protected.
- G. High Intensity Discharge (HID) Ballasts: Electronic.
1. HID ballasts shall be constant-wattage autotransformer, pulse start or regulating high-power-factor type.
 2. Efficiency: 88 percent, as minimum.
 3. Power Factor: 70, or better.
 4. Properties: Auto-restart and Thermally Protected.
 5. Open-circuit operation will not reduce the average life of the HID ballast.
 6. HID ballasts shall have auxiliary, instant-on, quartz system that automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur and automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.
 7. HID ballasts shall be low-noise type with manufacturer's standard epoxy-encapsulated ballast designed to minimize audible fixture noise.
 8. HID ballasts shall have instant re-strike device as a solid-state potted module mounted inside HID fixture and shall be compatible with specified lamps, ballasts, and sockets. Re-strike range shall be 105 VAC to 130 VAC.
- H. Light Emitting Diode (LED) Drivers
1. Light loss and physical failure shall comply with L70 for an expected lifetime of 50,000 hours, or better.
 2. Light loss and color rendering index (CRI) rating shall comply with Code 8, or 80% as a minimum.
 3. Power factor shall be 85%, or better, when operated at 120 VAC.
 4. LED modules and LED luminaires shall comply with the performance requirements of the latest versions of the International Electro-technical Commission (IEC) publically available specification (PAS) numbers 62717 and 62722.
 5. LED modules and LED luminaires shall have a ten (10)-year operational life while operating with a case temperature range of 0 degrees C (32 degrees F) to 62 degrees C (167 degrees F) and 90 percent non-condensing relative humidity.
 6. Maximum inrush current for LED module shall not exceed 2 amperes for 120V and 277V drivers and shall have no visible change in light output with a variation of +/- 10 percent line voltage input.
 7. Compatibility of driver and LED light engine must be tested and ensured by driver manufacturer. Drivers shall track evenly across multiple fixtures and at all light levels.
 8. Drivers intended for outdoor applications and suitable for wet locations and rated for NEMA 4 or IP 64.
 9. Operating temperatures: -29 degrees C (-20 degrees F) to 66 degrees C (150 degrees F).
 10. Calculated mean time between failures (MTBF) shall be greater than 100,000 hours, when operating at full load and 25 degrees C, (77 degrees F) ambient temperature.

11. Electrical filtering for electromagnetic compatibility (EMC), electromagnetic interference (EMI) or radio frequency interference (RFI) shall comply with federal standards established by 47 CFR Parts 2 and 15.
12. Drivers shall be UL 48/1310 Class 2 certified.
13. Maximum power requirements shall be less than 100 watts, unless noted otherwise.
14. Driver shall have integral protection for over-current, over-voltage and short circuits.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Lamps installed in lighting fixtures shall be as specified in the fixture schedule on the drawings and as specified herein. All lamps shall be operating at the time of final inspection.
- B. Install luminaires securely, in a neat and workman-like manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting). All luminaires shall be installed plumb, square and aligned with building lines and with adjacent luminaires.
- C. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by the Engineer. Secure locking fittings in place. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by the Engineer or authority having jurisdiction.
- D. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by the Architectural Life Safety Plan, Engineer or authority having jurisdiction (AHJ), with ascending priority.

END OF SECTION

**SECTION 16510
INTERIOR LIGHTING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. LED Luminaires
- D. Exit signs.
- E. Fluorescent dimming ballasts and controls.
- F. Fluorescent emergency power supply units.
- G. Luminaire accessories.

1.02 RELATED REQUIREMENTS

- A. Electrical Boxes.
- B. Electrical Raceways.

1.03 REFERENCE STANDARDS

- A. ANSI C78.379 - American National Standard for Electric Lamps – Reflector Lamps – Classification of Beam Patterns.
- B. ANSI C82.1 - American National Standard for Lamp Ballast - Line Frequency Fluorescent Lamp Ballast.
- C. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type).
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association.
- F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; National Fire Protection Association.

- I. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- J. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.04 DEFINITIONS

- A. BF: Ballast factor is the ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.
- B. CRI: Color rendering index is a measure of the ability of a light source to reproduce the colors of various objects being lit by the source. It is measured by comparing the color rendering of the test source to that of a black body radiator source, such as an incandescent lamp. CRI measurements range from 0 to 100, where 100 is the best color rendition. For example, an incandescent lamp will have a CRI of 100 and some tri-phosphor fluorescent lamps may have a CRI of 80 to 90.
- C. Color Temperature and Correlated Color Temperature: Related to CRI is the color temperature of the lamp, expressed in degrees Kelvin (K). The color temperature of a light source is determined by comparing its chromaticity with a theoretical, heated black-body radiator. The temperature at which the heated black-body radiator matches the color of the light source is the color temperature of that source. Many light sources, such as fluorescent lamps, do not emit light because of the temperature of the source and the emitted radiation does not follow the form of a black-body spectrum and is assigned a correlated color temperature (CCT). For example, a fluorescent lamp may be specified with a correlated color temperature of 3500 K.
- D. CU: Coefficient of utilization is a measure of the efficiency of a luminaire (lighting luminaire) in transferring luminous energy to the working plane in a particular area. It is the ratio of lumens from a luminaire incident upon a work plane relative to the lumens emitted by the lamps within the luminaire and measures the light actually reaching the desired plane as a percentage of the total light produced by the luminaire.
- E. LER: Luminaire efficiency rating calculated according to NEMA LE-5 or estimated from photometric data using the following formula: LER is equal to the product of rated lamp lumens times BF times luminaire efficiency, divided by input watts.
- F. RCR: Room cavity ratio is calculated as 2.5 times the room cavity depth (RCD) times the perimeter of the room divided by the area of the room. The room cavity depth is the depth, in feet, from the luminaire (lighting luminaire) to the work-plane.

1.05 SUBMITTALS

- A. See Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- C. Product Data: For each type of luminaire scheduled, arranged in order of luminaire designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including dimensions and verification of indicated parameters.
 - 2. Battery and charger for emergency lighting units.
 - 3. Ballasts for fluorescent and high-intensity-discharge (HID) luminaires.

4. Lamps to be used in each luminaire type.
 5. Photometric data based on laboratory tests of each lighting luminaire type with lamps, ballasts and accessories identical to those indicated for the lighting luminaire for this Project.
 6. Energy efficiency data.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Conform to requirements of NFPA 101.

1.07 EXTRA MATERIALS

- A. See Product Requirements, for additional provisions.
- B. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps: One (1) for every 10 of each type and rating installed. Furnish at least one of each type.
 2. Plastic Diffusers and Lenses: One (1) for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Battery and Charger: One (1) for each emergency lighting unit.
 4. Ballasts: One (1) for every 100 of each type and rating installed. Furnish at least one of each type.
 5. Globes and Guards: One (1) for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

2.02 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products that comply with requirements of NFPA 101.
- D. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

- F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

2.03 LIGHT EMITTING DIODE (LED) LUMINAIRES

- A. Light loss and physical failure shall comply with L70 for an expected lifetime of 50,000 hours, or better.
- B. Light loss and color rendering index (CRI) rating shall comply with Code 8, or 80% as a minimum.
- C. Power factor shall be 85%, or better.
- D. LED modules and LED luminaires shall comply with the performance requirements of the latest versions of the International Electro-technical Commission (IEC) publically available specification (PAS) numbers 62717 and 62722.
- E. LED modules and LED luminaires shall have a ten (10)-year operational life while operating with a case temperature range of 0 degrees C (32 degrees F) to 62 degrees C (167 degrees F) and 90 percent non-condensing relative humidity.
- F. Maximum inrush current for LED module shall not exceed 2 amperes for 120V and 277 V drivers and shall have no visible change in light output with a variation of +/- 10 percent line voltage input.
- G. Compatibility of driver and LED light engine must be tested and ensured by driver manufacturer. Drivers shall track evenly across multiple fixtures and at all light levels.

2.04 EMERGENCY LIGHTING UNITS

- A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- C. Battery:
 - 1. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- F. Provide accessories and fittings as recommended by manufacturer to properly and completely install and wire Luminaires.
- G. Electrical Characteristics: 120 volts, 60 Hz, unless otherwise indicated.

- H. Furnish products as indicated in the Luminaire Schedule included on the Drawings.

2.05 LUMINAIRE TYPES

- A. Furnish products as indicated in Schedule included on the Drawings.
- B. Luminaire: Furnish products as indicated in the Luminaire Schedule included on the Drawings:
- C. Emergency Lighting Units: Self-contained fluorescent emergency lighting unit.
1. Self-contained emergency lighting units shall comply with UL 924.
 2. Self-contained emergency lighting units shall have a sealed, maintenance-free, lead-acid type battery with a minimum 10 year nominal life and special warranty.
 3. Self-contained emergency lighting units shall have a fully automatic, solid-state type charger with a sealed transfer relay.
 4. Self-contained emergency lighting units shall be relay operated to automatically turn lamps on when power supply circuit voltage drops below 80 percent of nominal voltage, and automatically disconnects lamps from battery when normal voltage is restored. Relay shall also disconnect lamps from the battery when voltage approaches deep-discharge level. Battery shall be automatically recharged and floated on charger.
 5. Emergency power connection shall operate one (1) fluorescent lamp continuously at 1100 lumens, minimum. Unit shall connect un-switched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 6. Where a wire guard is specified for a self-contained emergency lighting unit, wire guard shall be heavy chrome-plated wire that protects the lamp or Luminaire head.
 7. Battery: 6 or 12 volt (see Luminaire Schedule), nickel-cadmium type, with 1.5 hour capacity.
 8. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.
 9. Housing: Steel with gray hammer tone finish and vinyl wood grain front panel.
 10. Indicators: Lamps to indicate AC ON and RECHARGING. Voltmeter to indicate battery voltage.
 11. TEST switch: Transfers unit from external power supply to integral battery supply.
 12. Electrical Connection: Conduit connection.
 13. Input Voltage: 120 or 277 volts, unless otherwise shown or noted on the Drawings.
 14. Product: Furnish products as indicated in the Luminaire Schedule included on the Drawings

2.06 EXIT SIGNS

- A. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
1. Number of Faces: Single or double as indicated or as required for the installed location.

- 2. Directional Arrows: As indicated or as required for the installed location.
- B. General Requirements: Comply with UL 924, and for sign colors and lettering size, comply with requirements of authority having jurisdiction (AHJ).
- C. Internally Lighted Exit Signs:
 - 1. Lamps for AC operation shall have light-emitting diodes rated at 70,000 hours, minimum lamp life.
- D. Manufacturers:
 - 1. Shall be as shown in the Luminaire Schedule on Drawings.
- E. Exit signs shall be suitable for use as emergency lighting unit and comply with the following requirements:
 - 1. Provide luminaires complying with NFPA 101.
 - 2. Manufacturers shall be as shown in the Luminaire Schedule on Drawings.
 - 3. Directional Arrows: Universal type for field adjustment.
 - 4. Mounting: Universal, for field selection.
 - 5. Lamps: Provide manufacturer's standard lamps, as shown in the Luminaire Schedule on the Drawings.

2.07 FLUORESCENT EMERGENCY POWER SUPPLY UNITS

- A. Description: Self-contained fluorescent emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Compatibility:
 - 1. Ballasts: Compatible with electronic, standard magnetic, energy saving, and dimming AC ballasts, including those with end of lamp life shutdown circuits.
- C. Operation: Upon interruption of normal power source, solid-state control automatically switches connected lamp(s) to the fluorescent emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- D. Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.
 - 1. Ballast input watts can be reduced from 20 to 100 percent of normal, proportional to dimming.
 - 2. Compatibility of ballast shall be certified by manufacturer for use with dimming system indicated on plans.
- E. Dimming Control Units: Linear slide type, rated 1000 watts at 120 volts.
 - 1. Ballast: Selected by dimming system manufacturer as suitable for operation with control unit.
 - a. Starting Method for Fluorescent Luminaires: Programmed rapid.
 - b. Ballast Factor for Fluorescent Luminaires: 1.00.

- F. Fluorescent Lamp Emergency Power Supply: Emergency battery power supply suitable for installation in ballast compartment of fluorescent luminaire.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Coordinate locations of outlet boxes as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workman-like manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Surface Mounted Luminaires: Install plumb and square and aligned with building lines and with each other; secure to prevent movement.
- F. Suspended Ceiling Mounted Luminaires:
 - 1. Install at locations indicated on reflected ceiling plan.
 - 2. Support luminaires of all sizes independently of the ceiling grid and anchored directly to building structure. Refer to suspension details shown on drawings.
 - 3. Install clips to secure luminaires in place.
 - 4. Luminaires Recessed in Ceilings: Install to permit removal from below.
 - 5. Suspended Luminaires: Install using pendants supported from swivel hangers, with pendant length as required for indicated height.
- H. Wall Mounted Luminaires: Install at height as indicated on the drawings.
- I. Recessed Luminaires: Comply with NEMA LE-4 for ceiling compatibility of recessed luminaires. Provide flexible conduit whip in maximum length of six (6) feet for recessed luminaires for connection to external J-boxes, unless junction boxes are integral in pre-wired systems.
- J. Luminaire supports shall comply with the following requirements applicable to the support and luminaire type specified and provided.
 - 1. Single Stem Hangers: One 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish shall be same as luminaire.
 - 2. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single luminaire. Finish shall be same as luminaire.
 - 3. Wires: Comply with ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gauge (2.68 mm).
 - 4. Wires In Humid Spaces: Comply with ASTM A 580/A 580M, stainless steel composition type 302 or 304, 12 gage (2.68 mm).
 - 5. Rod Hangers: 3/16 inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

- 6. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- 7. Aircraft Cable Support: Use cable, anchorages and intermediate supports recommended by luminaire manufacturer.
- K. Install accessories furnished with each luminaire.
- L. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire; use flexible conduit.
- M. Connect luminaires and exit signs to branch circuit outlets using flexible conduit.
- N. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- O. Bond products and metal accessories to branch circuit equipment grounding conductor.
- P. Install specified lamps in each luminaire, emergency lighting unit and exit sign.

3.02 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by the Engineer. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by the Engineer or authority having jurisdiction.
- C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by the Engineer or authority having jurisdiction.
- D. Aim and adjust luminaires as indicated.
- E. Position exit sign directional arrows as indicated.

3.03 CLEANING

- A. Remove all plastic covers and protective coatings.
- B. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.
- C. Clean electrical parts to remove conductive and deleterious materials.
- D. Remove dirt and debris from enclosures.
- E. Clean finishes and touch up damaged surfaces.

END OF SECTION

**SECTION 16720
FIRE ALARM SYSTEM**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This specification describes a Proprietary Fire Detection and Evacuation system as well as the "on premises" integrated fire detection and evacuation system with two way firefighters communications capabilities and firemen's HVAC override control panel, to be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The features and capacities described shall be furnished with the following features:
 - 1. The system shall be installed, tested, and delivered to the owner in fully operational condition.
 - 2. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized therein.
- B. Fire alarm system design and installation, including all components, devices, wiring, and conduit.
- C. Transmitters for communication with supervising station.
- D. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated, if applicable.
- E. Maintenance of fire alarm system under contract for specified warranty period.

1.02 RELATED REQUIREMENTS

- A. Fire stopping: Materials and methods for work to be performed by this installer.
- B. Overhead Coiling Doors: Coiling fire doors to be released by fire alarm system.
- C. Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
- D. Fire Pumps: Supervisory devices.
- E. Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- F. Clean-Agent Fire Extinguishing System: Supervisory, alarm, and releasing devices installed in extinguishing system.
- G. Passenger Elevators: Elevator systems monitored and controlled by fire alarm system.
- H. Facility Chutes: Sensors and interlocks monitored by fire alarm system.
- I. Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.
- J. General Provisions.

- K. Basic Electrical Materials and Methods.
- L. Grounding and Bonding for Electrical Systems.
- M. Hangers and Supports for Electrical Systems.
- N. Identification for Electrical Systems.
- O. Low-Voltage Electrical Power Conductors and Cables.
- P. Conduit.
- Q. Cable Trays for Electrical Systems.
- R. Boxes.
- S. Electrical Cabinets and Enclosures.

1.03 REFERENCE STANDARDS

- A. IEEE C62.41.2 – Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
- B. IEEE C62.41 – IEEE Recommended Practice on Surge Voltages in Low-Voltage Power Circuits.
- C. NFPA 70 – National Electrical Code (NEC).
- D. NFPA 72 – National Fire Alarm and Signaling Code.
- E. NFPA 101 – Life Safety Code.

1.04 SUBMITTALS

- A. See Administrative Requirements, for submittal procedures.
- B. Shop drawings for the Fire Alarm System (FAS) shall be submitted to the Fire Marshall's Office for final review and approval before installation work is started. Shop drawings shall comply with these requirements:
 - 1. Shop drawings for fire alarm system (FAS) shall be designed, reviewed and approved by a technician certified by the National Institute for Certification in Engineering Technologies (NICET).
 - 2. Shop drawings shall include circuit loads, battery loads and other calculations required by applicable codes, including the most currently approved editions of NFPA 72 – National Fire Alarm Code (NFAC) or International Fire Alarm Code (IFAC), as applicable.
- C. Proposal Documents: Submit the following with cost/time proposal:
 - 1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
 - 3. Certification by Contractor that the system design will comply with the contract documents.

4. Proposed maintenance contract.
- D. Evidence of designer qualifications.
- E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 1. Copy (if any) of list of data required by authority having jurisdiction (AHJ).
 2. NFPA 72 "Record of Completion", filled out to the extent known at the time with appropriate approvals by an authorized representative of the authority having jurisdiction (AHJ).
 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72, and complete listing of software required.
 4. System zone boundaries and interfaces to fire safety systems.
 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 10. Detailed drawing of graphic annunciator(s).
 11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 12. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
 13. Certification by Contractor that the system design complies with the contract documents.
 14. Do not show existing components to be removed, if applicable.
- F. Evidence of installer qualifications.
- G. Evidence of instructor qualifications; training lesson plan outline, if appropriate.
- H. Evidence of maintenance contractor qualifications, if different from installer.
- I. Inspection and Test Reports:
 1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit completed NFPA 72 "Inspection and Test Form."
- J. Operating and Maintenance Data: Revise and resubmit until acceptable; have one set available during closeout demonstration:
 1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.

2. Complete set of specified design documents, as approved by authority having jurisdiction (AHJ).
 3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 4. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 5. List of recommended spare parts, tools, and instruments for testing.
 6. Replacement parts list with current prices, and source of supply.
 7. Detailed troubleshooting guide and large scale input/output matrix.
 8. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 9. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- K. Project Record Documents: Maintain one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- L. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Certificate of Occupancy.
 4. Maintenance contract.
 5. Report on training results, if applicable for this work.
- M. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 2. In addition to the items in quantities indicated, furnish the following:
 - a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 - b. One copy, on CD-ROM, of all software not resident in read-only-memory, if applicable to system installed.
 - c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.05 QUALITY ASSURANCE

- A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.
- B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction (AHJ).
- C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
 - 4. Contract maintenance office located within 50 miles (80 km) of project site.
 - 5. Certified within the jurisdiction of this job as a fire alarm installer.
- D. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- E. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.06 EXTRA MATERIALS AND TOOLS

- A. Provide spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data give to Owner for spare parts inventory.
- B. In addition to the items in quantities indicated in PART 2, provide the following:
 - 1. CD-ROM copies, 2, of all software not resident in read-only-memory.
 - 2. Fuses, 2 for each installed fuse; store inside applicable control cabinet.

1.07 WARRANTY

- A. See Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Fire Alarm Control Units - Basis of Design: SimplexGrinnell:
www.simplexgrinnell.com.
- B. Fire Alarm Control Units - Other Acceptable Manufacturers: Provided their products meet or exceed the performance of the basis of design product, products of the following are acceptable:
 - 1. Honeywell Security & Fire Solutions/Gamewell-FCI.
 - 2. Honeywell Security & Fire Solutions/Notifier.
 - 3. Siemens Building Technologies.
 - 4. SimplexGrinnell.
 - 5. Edwards Signaling, a unit of UTC Fire & Security.
 - 6. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.
 - 7. Provide all control units and devices made by the same manufacturer.
- C. Initiating Devices, and Notification Appliances:
 - 1. Same manufacturer as control units.
 - 2. Provide all initiating devices and notification appliances made by the same manufacturer.

2.02 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in the contract documents or not.
 - 2. Protected Premises: As shown on the drawings and plans.
 - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. The Americans with Disabilities Act (ADA).
 - b. The requirements of the State Fire Marshal.
 - c. The requirements of the local authority having jurisdiction.
 - d. Applicable local codes.
 - e. The contract documents (drawings and specifications).
 - f. NFPA 101.
 - g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - h. NFPA 99, for healthcare occupancies.
 - 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
 - 5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.

6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
 7. Program notification zones and voice messages as directed by Owner.
 8. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
 9. Fire Command Center: Location indicated on drawings.
 10. Master Control Unit (Panel): New, located at location shown on the drawings.
 11. Two-Way Telephone: Provide two-way telephone service for the use of the fire service and others; provide jacks and two portable handsets.
 12. Combined Systems: Do not combine fire alarm system with other non-fire systems.
- B. Supervising Stations and Fire Department Connections:
1. Public Fire Department Notification: By on-premises supervising station.
 2. On-Premises Supervising Station: New proprietary station operated by Owner.
 3. Means of Transmission to On-Premises Supervising Station: Directly connected non-coded system.
- C. Circuits:
1. Initiating Device Circuits (IDC): Class B, Style A.
 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
 3. Signaling Line Circuits (SLC) Between Buildings: Class A, Style 2.
 4. Notification Appliance Circuits (NAC): Class B, Style W.
- D. Spare Capacity:
1. Initiating Device Circuits: Minimum 25 percent spare capacity.
 2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
 3. Speaker Amplifiers: Minimum 25 percent spare capacity.
 4. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
 2. Secondary: Storage batteries.
 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.03 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.
 2. Dry-pipe sprinkler system pressure.
 3. Dry-pipe sprinkler valve room low temperature.
 4. Fire pump(s).
 5. Elevator shut-down control circuits.

- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 - 1. Sprinkler water flow.
 - 2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
 - 3. Elevator lobby, elevator hoist way, and elevator machine room smoke detectors.
 - 4. Duct smoke detectors.
- C. Elevators:
 - 1. Elevator lobby, hoist way, and machine room smoke detectors: Elevator recall and fire fighters' service. Provide one smoke detector in each elevator lobby and each machine room for each elevator cab to control that elevator. Provide heat and smoke detectors in each elevator shaft for each elevator cab to control that elevator.
 - 2. Provide control modules for each elevator controller to signal smoke detection on the primary and secondary floors and to illuminate the Fire Fighter's Hat in the elevator cab.
 - 3. Elevator Machine Room Heat Detector: Provide control module to shunt trip each elevator power circuit before sprinkler water flow occurs in each elevator room.
 - 4. Sprinkler pressure or water flow: Provide smoke detectors in each elevator lobby for each elevator cab to control that elevator and shut down elevator upon sprinkler flow.
- D. HVAC
 - 1. Duct Smoke Detectors: Provide control modules to close dampers indicated and shut down air handlers indicated.
 - 2. Smoke damper position indicator: Monitoring points are required for both open and closed positions.
 - 3. Building management system (BMS): Provide control modules to interface with the BMS to shut down HVAC systems.
- E. Doors
 - 1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.
 - 2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from.

2.04 COMPONENTS

- A. General:
 - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 - 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

- B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed by Underwriters Laboratories as suitable for the purpose intended.
- C. Master Control Unit: As specified for Basis of Design above, or equivalent.
- D. Initiating Devices
- E. Notification Appliances
- F. Circuit Conductors: Copper or optical fiber; provide 200 feet (60 m) extra; color code and label.
- G. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
 - 1. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 VDC maximum DC clamping voltage of 36 VDC, line-to-ground, and 72 VDC, line-to-line.
- H. Locks and Keys: Deliver keys to Owner.
 - 1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type
- I. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
 - 1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 - 2. Provide one for each control unit where operations are to be performed.
 - 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 - 4. Provide extra copy with operation and maintenance data submittal.
- J. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.
 - 1. Padlock eye and hasp for lock furnished by Owner.
 - 2. Locate as directed by Owner.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
- B. All wiring installed in finished areas or in any areas below 8' above the finished floor (AFF) shall be installed in conduit, boxes and electrical cabinets and enclosures with appropriate supports and proper identification.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.

3.02 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- H. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
 - 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 - 1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.04 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.

4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 5. Repeat demonstration until successful.
- B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
1. Specified diagnostic period without malfunction has been completed.
 2. Approved operating and maintenance data has been delivered.
 3. Spare parts, extra materials, and tools have been delivered.
 4. All aspects of operation have been demonstrated to Owner.
5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 6. Occupancy permit has been granted.
 7. Specified pre-closeout instruction is complete.

3.05 MAINTENANCE

- A. See Section 01 7000 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.
- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- D. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 2 hours of notification.
 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- G. Comply with Owner's requirements for access to facility and security.

END OF SECTION

FIRE ALARM SYSTEM SECTION 16720 - 11

**SECTION 16740
TELEPHONE SYSTEMS**

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the addition of outlets to telephone system, including all accessories as shown by the drawings and hereinafter specified.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to sections 16110 and 16134 of these specifications.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The telephone system shall be installed in accordance with the requirements of the telephone system supplier and utility providing service.
- B. Provide all wiring and conduit for the telephone system as follows.
 - 1. Patient Rooms – 3 Pair 22 gauge UL listed type “CMR” to nearest telephone terminal board. Provide a 4” x 4” outlet box, extension ring and blank cover plate with conduit routed above the ceiling in the corridor outside the resident room, terminate with an end bushing.
 - 2. Office or Business Areas – 3 Pair 22 gauge UL listed type “CMR” to nearest telephone terminal board. Provide a 4” x 4” outlet box, extension ring and blank coverplate with conduit stubbed 6” above accessible ceiling, terminate with an end bushing.
- C. Run all wiring to respective telephone terminal board and provide a 5’-0” pigtail at telephone terminal board and 1’ pigtail at device location. All cable will be bundled and run in a neat workmanlike manner above the ceiling and supported from structure.
- D. All outlets and final terminations will be provided and installed by the telephone system supplier.
- E. The telephone backboard shall be 4’ x 8’ x ¾” plywood painted with two coats of gray enamel paint mounted directly to the wall or within a cabinet as indicated on the drawings.

END OF SECTION

**SECTION 16742
VOICE/DATA NETWORK CABLE SYSTEMS**

PART 1 – GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the addition of outlets to telephone system, including all accessories as shown by the drawings and herein after specified.
- B. The work included under this Section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary to provide a complete and operational voice/data network cable system.
- C. Contractor is expected to coordinate with voice utility service provider and owner prior to any work.

PART 2 – PRODUCTS**2.01 GENERAL REQUIREMENTS**

- A. All products shall be as indicated on plans with manufacturer etc or approved equal.
- B. All products shall have a UL listing.
- C. All products and installation of products shall be in accordance with all specifications and not conflict with any discipline.
- D. All Cabling shall be plenum rated.

2.02 CABLING

- A. All communications cabling used throughout this project shall comply with the requirements as outlined in the National Electric Code (NEC®) Articles 725, 760, 770, and 800 and the appropriate local codes.
- B. All copper cabling shall bear CMP (Plenum Rated) and/or appropriate markings for the environment in which they are installed.
- C. Cable Pathway
- D. In suspended ceiling and raised floor areas where duct, cable trays or conduit are not available, the Contractor shall bundle, in bundles of 50 or less, station wiring with cable ties snug, but not deforming the cable geometry.

- E. Cable bundles shall be supported via independent self-supporting means attached to building structure and at intervals of four (4) feet.
- F. Plenum rated cable ties shall be used in all appropriate areas.
- G. The Contractor shall adhere to the manufacturers' requirements for bending radius and pulling tension of all data and voice cables.
- H. Cables shall not be attached to lift out ceiling grid supports or laid directly on the ceiling grid.
- I. Cables shall not infer with fire sprinkler heads or delivery systems or any other life safety systems in the ceiling space.
- J. Cable shall be Cat 5e to data jacks indicated on plans.

2.03 CATEGORY 5e MODULAR PATCH PANELS

- A. The Category 5e modular patch panels shall meet or exceed the proposed Category 5e standards requirements in ANSI/TIA/EIA.
- B. The patch panels shall be 19-inch rack mountable
- C. Provide patch cord organizers between each modular patch panel
- D. Shall have horizontal routing via metal distribution rings
- E. Shall have 24 plastic clips to provide vertical pathways for patch cables

2.04 COPPER PATCH CORDS

- A. Category 5e Patch Cords
- B. All patch cords shall meet or exceed ANSI/TIA/EIA and ISO/IEC Category 5e specifications.
- C. All patch cords shall be compatible with Category 5 and Category 5e systems.
- D. The patch cords shall incorporate an anti-snap feature that provides maximum protection from snagging during moves and re-arrangements.
- E. Patch cords shall be, UL-C certified and AUSTEL approved.
- F. Patch cords shall support network line speeds.
- G. Patch cords shall be available in stranded and solid conductor in lengths to 100 feet.

2.05 TELECOMMUNICATION COPPER CABLE

- A. Shielded 24 AWG multi-pair copper cables are used to communication rooms for voice transmissions.
- B. Shielded
 - 1. The shielded riser rated cable shall consist of solid-copper conductors insulated with and covered by a PVC skin, be conformance tested to meet EIA/TIA 568-B for Category 3 cables, be UL® listed as CMR. The core shall be overlaid with a

corrugated aluminum sheath, which is adhesively bonded to an outer jacket of PVC plastic to form an ALVYN sheath.

2. The PVC sheath shall allow it to be pulled through conduit without the use of additional lubricants.
3. The cable shall be available in 50, 100, 150, 200, 300, 400, 600, 900, 1200, 1500, and 1800 pair counts.

2.06 110 PUNCH BLOCK

- A. The punch block shall support Category 5e applications and facilitate cross connection and interconnection using either cross connect wire or the appropriate category patch cords.
- B. Series of fanning strips shall be located on each side of the block for dressing the cable pairs terminated on the adjacent index strips.
- C. The wiring block shall accommodate 19- through 26-AWG conductors and shall be able to mount directly on wall surfaces with backboards or 19" free-standing frame.
- D. The punch blocks shall be fire retardant, molded plastic consisting of horizontal index strips for terminating 25 pairs of conductors each. The index strips shall be marked with five colors on the high teeth, separating the tip and ring of each pair, to establish pair location.
- E. Clear label holders with the appropriate colored inserts shall be provided with the punch blocks. The insert labels shall contain vertical lines spaced on the basis of circuit size (3-, 4-, or 5-pair) and shall not interfere with wire/patch cords.
- F. The punch blocks shall be available in 100 and 300 pair sizes and shall be available with legs.
- G. The punch block shall be able to accommodate over 500 repeated insertions without incurring permanent deformation and it shall pass the reliability test of no more than one contact failure in 10000 connections.
- H. Jumper Trough
- I. Provide a horizontal trough for the routing of patch cords and/or cross connect wire.
- J. Provide between each punch block and top and bottom of each group of punch blocks.
- K. Provide patch cord organizers between each modular patch panel
- L. Shall have horizontal routing via metal distribution rings
- M. Shall have 24 plastic clips to provide vertical pathways for patch cables

2.07 OUTLETS

- A. Outlet Faceplates
- B. Flush – Mount faceplates shall be available in single, duplex, triplex, quadplex, or sixplex arrangement in a single gang configuration.
 1. The outlets shall be capable of being installed in any modular faceplate, frame, or surface-mounted box avoiding the need for special faceplates.

2. Faceplates, One-Port, Two-Port, Three Port, Four Port and Six Port
 - a) Ivory shall be the color
- C. Outlet Requirements.
- D. Unless otherwise noted on the floor plans or within this document, all voice and data wall outlets for 24 AWG copper cable shall be:
 1. Insulation displacement with eight position and eight conductor modular outlets
 2. Support Universal applications in a multivendor environment, accepting modular RJ-45 plugs. .
 3. Provide color coded inserts at each outlet, termination block and at patch panels.
 4. Mounted in one, two or three gang utility outlet boxes.
 5. Universal wiring labels EIA/TIA-T568A and EIA/TIA-T568B.

2.08 EQUIPMENT RACKES

- A. General
 1. The equipment rack shall support the patch cords at the front of the rack provide vertical cable management, wire management, and protection for the horizontal cables inside the legs of the rack. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels for protection and to maintain proper bend radius and cable support. Each patch panel and/or piece of equipment on the rack shall be provided with wire management. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Rack shall be black in color to match the patch panels and cable management.
- B. Free-standing rack shall have the following
 1. Means for providing proper strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B.
 2. Top cable trough with waterfall and built in patch/horizontal cable distribution separator.
 3. EIA hole pattern on front and rear.
 4. 6.5" channel depth.
 5. Hook and loop straps for securing bulk cables inside the vertical U-channels.
 6. 19" mounting with a height of 7 ft
 7. Vertical patch cord management.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The telephone system shall be installed in accordance with the requirements of the telephone system supplier and utility providing service.
- *B. Provide all wiring and conduit for the telephone system as follows.
 1. Telephone outlets shall consist of a 4" square device box, single gang device box coverplate and ¾" conduit stubbed 6" into ceiling.

2. Outlet terminations shall consist of 4 pair cable terminated on an ortronics dual RJ-11 jack module.
 3. All cabling shall be terminated at the main telephone terminal board utilizing 110 punchdown blocks.
 4. Cabling shall be run exposed in the ceiling space, bundled and installed in a neat workmanlike manner. Cabling shall be supported from the structure
- *B. The contractor shall be responsible for providing and installing the following materials as a basis for the system:
1. Fire rated painted plywood backboard, for equipment mounting and wiring termination, in each communications room.
 2. A 4-11/16" device box, plaster ring and appropriate cover plate with a minimum 3/4" conduit stubbed into ceiling space at each computer/telephone location indicated on plans.
 3. A 4-11/16" device box, plaster ring and appropriate cover plate with a minimum 3/4" conduit stubbed into ceiling space at each resident room.
 4. Each outlet shall have a duplex type coverplate with appropriate number RJ45 jacks as plans indicate. Refer to plans for cable requirements at each location.
 5. All cabling shall home run from its respective outlet location to the local communications room
- C. Contractor shall coordinate. Within the main communication rm location the contractor shall provide the following:
1. Standard Cat – 5 patch panels fastened to equipment Rack of back board.
 2. Flat wire shelf fastened to backboard approximately 2'-0" below Cat – 5 patch panels. Hub to be provided by owner and placed on rack.
 3. 3 foot patch cords (quantity as required) for connection between hub and patch panels.
 4. Additional wire shelf 2'-0" below the first shelf for owner provided UPS.
- D. The contractor shall be responsible for providing one seven (7) foot patch cord for every data jack outlet and a supply of fifteen (15) foot patch cords equaling in number to 50% of all data jack outlets.

3.02 GROUNDING AND BONDING

- A. All grounding and bonding shall meet the National Electrical Code (NEC®) as well as local codes which specify additional grounding and/or bonding requirements.
- B. Bonding and Grounding
- C. Communication bonding and grounding shall be in accordance with the NEC® and NFPA. Horizontal cables shall be grounded. Horizontal equipment includes cross connect frames, patch panels and racks, active telecommunication equipment and test apparatus and equipment. General Contractor shall provide when required by local code Bonding utilizing a #6-AWG.

3.03 FIRE STOPPING

- A. Fire Stopping Openings around the exterior and interior of the sleeves or openings between floors, through rated fire and smoke walls, existing or created by the Contractor for cable pass through shall be the responsibility of the Contractor for proper sealing.

- B. Contractor shall be responsible for providing openings as indicated and necessary according to drawings.
- C. All unused conduits and openings indicated on communications plans shall be sealed by contractor.
- D. Damage Responsibility
- E. Any surfaces or work disrupted as a result of work shall be repaired by this includes painting and shall be included as necessary.

3.04 TESTING AND DOCUMENTATION

- A. All cables shall be tested to verify satisfactory end-to-end cable performance.
- B. Cable links shall be tested for near-end crosstalk and attenuation up to and including 100 MHz.
- C. The network cable system shall be certified in writing for up to 100 MHz operation in the form of a 10-year performance warranty.
- D. The completed network cable system shall be documented in the form of "As-Built" drawings identifying the cable path, links and data jack outlets.

END OF SECTION

**SECTION 16784
KEYLESS ENTRY SYSTEMS**

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. The work included under this section of these specifications consists of furnishing all material and equipment and performing all labor and services necessary for the installation of the keyless entry system, including all related systems and accessories as shown by the drawings and hereinafter specified.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. The Electrical Contractor will furnish and install all equipment, conduit, and wiring as shown on the plans, as herein specified and as required for a complete and operating keyless entry system.
- B. The system shall be installed under the supervision of the equipment supplier, who will test the system once installed.
- C. The equipment specified is that of DSX Inc. other manufacturers which meet the requirements of this specifications will be acceptable, subject to substitution requirements of Section 16010
- D. System Operations
 - 1. Doors Locked through magnetic locks and electric strikes.
 - 2. Doors opened through proximity transmitters which deactivate a magnetic lock for a preset time.
 - 3. Doors opened from proximity transmitters which deactivate an electric strike for a preset time.
 - 4. When doors close, magnetic locks and electric strikes should be re-activated immediately
 - 5. All door operations upon system activation shall be recorded via system software.
 - 6. Upon loss of building power, doors shall fail secure.
- E. Equipment
 - 1. Provide a DSX 1048/1042 Panel(s) control system with True Non Volatile Memory for controlled access and monitoring for all exterior doors indicated. Each Controller operates as a fully intelligent and independent control panel that retains all data necessary for system operation in its own RAM. With its

integral real-time Clock and Calendar it performs Time Zone control with Holiday overrides for inputs, outputs, and cards even when communication to the PC or other controllers is not available. All DSX Controllers are designed and built for commercial and industrial use and carry a UL 294 and 1076 listing. All of the functionality is the same for the controllers but the form factor is different to accommodate different applications Coordinate exact type and quantity of doors with architectural plans.

2. Provide HID proximity reader(s), Model Prox Point.
3. Provide HES Strike 24VAC electric strikes with individual plug-in power supply transformers
4. Provide Securitron M62, 1200 lb. Maglocks for single side of front and rear club house entry doors. Provide each with universal header brackets and armored door cable.
5. Provide Securitron Model TSB-3 "Push to Exit" panic bars for single side of front and rear clubhouse egress doors.
6. Provide Securitron Model PB2E REX Buttons, Model WBB back boxes and WCC cover plates for pool deck access gates.
7. Provide Securitron UL Central Power Supply for maglocks. Provide battery backup for maglock power supply as required for fail secure operation.
8. Provide minimum 500 proximity transmitters for the keyfob type. Submit pricing with bid quotation.
9. Provide Computer software Win DSX by DSX inc. for remote system programming. WinDSX is a powerful access control and system monitoring application that harnesses the power of the Windows 32 and 64 bit operating systems. WinDSX combines point monitoring and access control with Photo ID Badging, Time and Attendance, Alarm Graphics, DVR/NVR Integration, Elevator Control, Alarm Email/Text Message Notification, Threat Level Management, HazMat and Emergency Lockdown, and FIPS/TWIC card compatibility.
10. Control System for access control shall be internally protected by multi-level surge suppression modules on power and data circuits.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Provide Class 2 application cabling as required by the manufacturer.
- B. Final Tests shall be made in the presence of a representative of the owner, who shall be notified of the test date a minimum of ten (10) days in advance.
- C. The Contractor shall furnish all equipment, material, cable, conduit and supplies required to effect the complete installation. Instruction manuals, schematic drawings and service instructions shall be submitted as shop drawings for approval.
- D. The system shall be guaranteed for a period of two (2) years from the date of acceptance against defective materials, design, workmanship, and improper adjustment. Any defective material shall be replaced at no expense to the owner.
- E. Conduit shall be utilized to the extent noted on the drawings.

- F. Preferred vendor capable of providing and installing the specified system is Accurate Electronics of Largo, Florida. Contact Mr. Derik Palmer at (813) 983-9131
- G. Submit operations and maintenance manual in accordance with Section 16010, Paragraph 1.16, as a condition of final acceptance.
- H. Provide 2 hours of instruction to Owner's Representative prior to project close out

END OF SECTION

SECTION 16865
ELECTRIC DUCT HEATER

PART 1 GENERAL**1.01 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.
- B. Refer to Section 16010 for Supplementary Conditions.

1.02 DESCRIPTION OF WORK

- A. This section includes the provision and installation of all materials, equipment and incidentals necessary and/or required for a complete installation of electric duct heaters as specified herein.
- B. Mounting as scheduled
 - 1. Slip in: horizontal

1.02 SUBMITTALS

- A. Product Data: Provide unit size, finish, performance and electrical capacities.
- B. Shop Drawings: Provide drawings with dimensional data and wiring diagram showing power and control connections. Differentiate between factory and field wiring.
- C. Submit manufacturer's installation instructions.

1.03 OPERATION AND MAINTENANCE DATA

- A. Include troubleshooting diagnostics
- B. Operation Data: Include instructions for replacement parts

1.04 FIELD MEASUREMENTS

- A. Verify that duct sizes and lengths of straight duct before and after duct heaters meet manufacturers' requirements.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. ENVIRO-TEC®
- B. Indeeco
- C. Brasch

2.02 ELECTRIC DUCT HEATER

- A. Description: Duct-mounted electric resistance heater, with terminal and integral or remote control box, element, casing and controls, listed for zero clearance between

heater and combustible material through a nationally recognized testing laboratory (NRTL) and bear label indicating compliance.

- B. Heating elements: Exposed helical coil of Grade A 80/20 nickel-chromium resistance wire with refractory ceramic support bushings, arranged across the full height of the frame to prevent stratification when operating at less than full capacity. Element terminals of stainless steel, machine crimped to the element. Terminal insulators constructed of ceramic and securely fastened to bracket.
 - 1. Watt Density: Standard watts per square inch is maximum of 60 watts, 35 watts per square inch.
- C. Casing: Die formed frame of 20 gauge galvanized steel with element support brackets spaced no more than 4" on center.
- D. Provide fully hinged and latched panel for electrical connection, control compartment spot welded construction with 20 gauge and cover with 18 gauge. Panel shall be totally enclosed without louvers or grills per UL standard 1096. Panel rated at NEMA 1, 3R, 4 or 12.
- E. Input Fuses: Provide integral fuses for units rated more than 48 amperes full load.
- F. Airflow interlock: Provide interlock to fan. Non-adjustable makes on pressure rise of .05" wc + | or -.02".
- G. Disconnecting methods: Provide through the door lockable fused disconnect.
- H. Safeties: Automatic primary reset over temperature thermal cut-out, manual reset secondary thermal cut-out. All safeties shall be serviceable through the control panel without removing the heating coil.
- I. Contactor: Provide control contactor per step; magnetic contactors.
- J. Provide low voltage control transformer: Fused primary and secondary
- K. Provide terminal blocks for power and control wiring connections.

2.03 ACCESSORIES

- A. Electronic Step Controller
 - 1. Operating signals by others: [4-20ma] [2-10vdc]
 - 2. Wall thermostat
 - 3. Duct thermostat ranges: 50 degrees F to 90 degrees F.

2.04 QUALITY ASSURANCE

- A. Manufacturer's Qualification: Engaged in manufacturing of electric duct heaters of types, sizes and ratings, whose products have been in satisfactory operation for not less than five (5) years.
- B. Construction: Unit constructed in accordance with NEC and UL 1096 and bear label indicating such. All internal wiring shall be copper conductors with 105 degrees Celsius insulation.

- C. Testing Standards: Dielectric voltage withstand test at 1,000 volts for units rated 250 volts or less and 1,000 volts plus twice rated voltage for units rated greater than 250 volts.
- D. Installation, operational and special instructions included inside the control cabinet.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Verify that required utilities are available, in proper location and ready for use.
- C. Beginning of installation means installer accepts existing conditions.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions
- B. Install unit with sufficient clearance from adjacent construction, piping, ductwork, and other obstructions to allow access for service and maintenance.
- C. Connect power and controls to duct heater as specified in Section 16142.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Install duct heaters in ductwork provided under provisions of Section 15841.
- B. Control duct heater from temperature control system provided under provisions of Section 15910.

3.04 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 15010.
- B. Verify operation of each electric duct heater by measuring input voltage current simultaneously for period of ten (10) minutes of continuous operation.

3.05 DEMONSTRATION

- A. Provide systems demonstration under provisions of Section 15010.
- B. Demonstrate location of circuit breakers and switches serving duct heater branch circuits, and location and setting procedures for thermostats and other heating controls.

END OF SECTION