

SECTION 15050 - BASIC MECHANICAL REQUIREMENTS

SECTION 15050- BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

- 1.1 SCOPE: Basic Mechanical Requirements specifically applicable all to Division 15 and 17 specifications, in addition to General Conditions, Supplemental General Conditions and Special Conditions.
 - A. Labor, materials, services, equipment and appliances required for completion of tasks as indicated on drawing or in specification or as inherently necessary for installation and testing of all HVAC, control, and testing systems.
- 1.2 DRAWINGS AND SPECIFICATIONS
 - A. Drawings accompanying these Specifications show intent of Work to be completed. Drawing notes and these specifications identify quality and grade of installation. Where equipment and hardware is not particularly specified, Contractor shall provide submittals for all products and install them per manufacturers' recommendations, and in a first class manner.
 - B. Examine Drawings and Specifications for elements in connection with this Work; determine existing and new general construction conditions and be familiar with all limitations caused by such conditions.
 - C. Plans are intended to show general arrangement and extent of Work contemplated. Exact location and arrangement of parts shall be determined after equipment has been approved by the College, as Work progresses, to conform in best possible manner with surroundings, and as directed by the College.
 - D. Do not scale from drawings. Dimensions on drawing shall be followed. Where dimensions are not provided Contractor shall coordinate with all trades to achieve the drawing intent.
- 1.3 WORK SEQUENCE: Install work in phases to accommodate College's occupancy requirements. Prior to the construction period, coordinate the mechanical schedule and operations with the College.
- 1.4 UTILITIES: Location and sizes of mechanical service facilities are shown in accordance with data secured from existing record drawings and limited site observations. Data shown are offered as an estimating guide without guarantee of accuracy. Contractor shall check and verify all data given, and verify exact location of all utility services pertaining to Work prior to excavation or performing Work.
- 1.5 COLLEGE FURNISHED PRODUCTS: Unless noted otherwise, all items shall be furnished by the Contractor for a complete and operational installation.
- 1.6 APPLICABLE CODES AND REGULATIONS: Meet requirements of all applicable local, state and federal codes and standards having jurisdiction including but not limited to:
 - A. State of California Code of Regulations:
 - 1. Title 8, Industrial Relations
 - 2. Title 19, State Fire Marshal Regulations
 - 3. California Building Code (CBC), Title 24, Part 2
 - 4. California Electrical Code, Title 24, Part 3
 - 5. California Mechanical Code, Title 24, Part 4
 - 6. California Plumbing Code, Title 24, Part 5
 - 7. California Fire Code, Title 24, Part 9
 - 8. California Standards Code, Title 24, Part 12
 - 9. Title 24, Energy Conservation Standards
 - B. NFPA - National Fire Protection Association Standards outlined in CBC 3801(d).
 - C. Codes and ordinances having jurisdiction over Work are minimum requirements; but, if Contract Documents indicate requirements which are in excess of those minimum requirements, then requirements of the Contract Documents shall be followed. Contractor shall identify any conflicts between Contract Documents and any codes or ordinances having jurisdiction and report these to the Engineer prior to proceeding with the work.

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- D. Obtain permits, and request inspections from authority having jurisdiction.

1.7 PROJECT/SITE CONDITIONS

- A. The arrangement of and connection to equipment shown on the drawings is based upon information available to the Engineer at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The drawings are, in part, diagrammatic and some features of the illustrated equipment installations may require revision to meet actual equipment installation requirements.
- B. Install Work in locations shown on approved Drawings, unless prevented by Project conditions.
- C. Prepare revised drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Engineer before proceeding.

1.8 COOPERATION WITH WORK UNDER OTHER DIVISIONS

- A. Cooperate with other trades to facilitate general progress of Work. Allow all other trades every reasonable opportunity for installation of their work.
- B. Work under this Division shall follow general building construction closely.
- C. Work with other trades in determining exact location of outlets, pipes, diffusers, and pieces of equipment to avoid interference with lines required to maintain proper installation of Work.
- D. Make such progress in the Work to not delay work of other trades.

1.9 DISCREPANCIES

- A. Refer to General Conditions.
- B. The Contractor shall check all drawings furnished him immediately upon their receipt and shall promptly notify the Engineer of any discrepancies. Figures marked on Drawings shall in general be followed in preference to scale measurements. Process and instrumentation diagrams shall in general govern floor plans and sections. Large scale drawings shall in general govern small scale drawings. The Contractor shall compare all drawings and verify the figures before laying out the work and will be responsible for any errors which might have been avoided thereby.

- 1.10 CHANGES: The Contractor shall be responsible to make and obtain approval for all necessary adjustments in piping, ductwork and equipment layouts as required to accommodate the relocations of equipment and/or devices which are affected by any approved authorized changes or Product substitutions. All changes shall be clearly indicated on the "Record" drawings.

1.11 SUBMITTALS

- A. Submit five (5) copies of each submittal to the University Representative, unless otherwise specified in the General Conditions or if the Contractor requires more than three (3) copies returned. Engineer will retain one (1) copy and one (1) copy will be forwarded to the College.
- B. Submit shop drawings, manufacturer's data certificates for equipment, materials and finish, and pertinent details for each system as grouped and referenced by the specification technical section numbers, and obtain approval before procurement, fabrication, or delivery of the items to the job site. Refer to drawings for additional submittal data.
- C. Partial submittals are not acceptable and will be returned without review.
- D. Include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable technical society publication references, and other information necessary to establish contract compliance of each item the Contractor proposes to furnish. Photographs of existing installations and data submitted in lieu of catalog data are not acceptable and will be returned without approval.

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- E. Contractor shall include with each submittal, applicable specification paragraphs listed with the differences noted for each paragraph or the words "No Exception" next to each paragraph.
- F. Contractor shall be responsible for reviewing and certifying submittals as conforming to the Drawings and Specifications prior to submittal and shall verify conformance of equipment as delivered with final shop submittals, specifications and plans. Contractor shall report to Engineer any deviations prior to initiation of Work. Contractor is responsible for promptly reporting to Engineer any news of late equipment delivery which is likely or certain to delay installation.
- G. Sequentially number the transmittal forms. Resubmittals shall have original number with an alphabetic suffix.
- H. Identify Cabrillo Community College District Bldg. 800, Project Number, Project Name, Contractor, Subcontractor or supplier, Engineer; pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.
- I. Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.
- J. Schedule submittals to expedite the Project and comply with time restraints of the General Conditions and Supplemental General Conditions, and deliver to the College. Coordinate submission of related items.
- K. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.
- L. Provide space for Contractor and Engineer review stamps.
- M. Revise and resubmit submittals as required, identify all changes made since previous submittal.
- N. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.
- O. Shop Drawings: Drawings shall be a minimum of 8.5 inches by 11 inches in size with a minimum scale of 1/4-inch per foot, except as specified otherwise. Site distribution piping shop drawings shall be a minimum scale of 1"=20' or larger. Include installation details of equipment indicating proposed location, layout and arrangement, accessories, piping, duct work, and other items that must be shown to assure a coordinated installation. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.
- P. Manufacturer's Data: For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, performance and characteristic curves if applicable, and catalog cuts.
- Q. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute (ANSI) or American Water Works Association (AWWA), submit proof of such conformance to the Engineer for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the College. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard.
- R. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.

1.12 PRODUCT ALTERNATIVES OR SUBSTITUTIONS: Refer to General Conditions.

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1.13 GUARANTEE

- A. Except as may be specified under other sections in the Specifications, guarantee all equipment furnished under the Specifications for a period of one year from date of project acceptance against defective workmanship and material and improper installation. Upon notification of failure, correct deficiency immediately and without cost to the College.
- B. Standard warranty of manufacturer shall apply for replacement of parts after expiration of the above period. Manufacturer shall furnish replacement parts to the College for their service agency as directed.

1.14 OPERATION AND MAINTENANCE MANUALS

- A. Format
 - a. Prepare data in the form of an instructional manual.
 - b. Binders: Commercial quality, 8-1/2 x 11 inch three-ring binders with hardback, cleanable, plastic covers; one inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
 - c. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; list title of Project and separate building; identify subject matter of contents.
 - d. Arrange content by systems and process flow under section numbers and sequence of Table of Contents of this Project Manual.
 - e. Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
 - f. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
 - g. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- B. Contents, Each Volume (Provide 4 copies)
 - a. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of the Engineer, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.
 - b. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
 - c. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
 - d. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
 - e. Type Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
- C. Manual For Equipment and Systems
 - a. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
 - b. Panelboard Circuit Directories: Provide electrical service characteristics, controls and communications.
 - c. Include color coded wiring diagrams as installed.
 - d. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
 - e. Maintenance Requirements: Include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
 - f. Provide servicing and lubrication schedule, and list of lubricants required.
 - g. Include manufacturer's printed operation and maintenance instructions.
 - h. Include sequence of operation by controls manufacturer.
 - i. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

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- j. Provide control diagrams by controls manufacturer as installed.
 - k. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.
 - l. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
 - m. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
 - n. Additional Requirements: As specified in individual product specification sections.
 - o. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.
- 1.15 INSTRUCTION TO COLLEGE PERSONNEL:
- A. Provide training as specified in individual sections.
 - B. Before final inspection, instruct the College's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times. Furnish the services of competent instructors to give full instruction to College personnel in the adjustment, operation, and maintenance of systems and equipment, including pertinent safety requirements. Each instructor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.
 - C. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.
 - D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with the College's personnel in detail to explain all aspects of operation and maintenance.
 - E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
 - F. Submit six copies of Manufacturer's Instruction Certificates as specified in individual specification Sections.
- 1.16 MANUFACTURER'S RECOMMENDATIONS: Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.
- 1.17 DELIVERY AND STORAGE: Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B P, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.
- 1.18 PROJECT RECORD DOCUMENTS
- A. Maintain on site, one set of the following record documents; record actual revisions to the Work:
 - a. Contract Drawings.
 - b. Specifications.
 - c. Addenda.
 - d. Change Orders and other Modifications to the Contract.
 - e. Reviewed shop drawings, product data, and samples.
 - B. Store Record Documents separate from documents used for construction. Record documents shall be available for review by the Construction Inspector and Engineer at all times.
 - C. Record information concurrent with construction progress.
 - D. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
 - a. Manufacturer's name and product model and number.

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- b. Product substitutions or alternates utilized.
- c. Changes made by Addenda and Modifications.
- d. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Field changes of dimension and detail.
 - 2. Details not on original Contract Drawings.
- B. All changes and information recorded on the set of prints maintained during the Work shall be neatly drawn and printed on a new set of plans in an orderly and legible manner, using approved permanent materials and methods. Any additional sheets necessary to complete the record drawings shall be provided by the Contractor and shall be of the same size, borderline, titling identification, and media as the record drawings.
- C. Submit completed documents (one set of original blueprints and one set of reproducibles) to the College prior to Completion.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 WORK RESPONSIBILITIES

- A. The drawings indicate diagrammatically the desired locations or arrangement of ducts, piping, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work so as to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference with structural conditions. The Contractor is responsible for the correct placing of Work and the proper location and connection of Work in relation to the work of other trades. Advise appropriate trade as to locations of access panels.
- B. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without extra cost, providing the change is ordered before the ductwork, piping, etc. and work directly connected to same is installed and no extra materials are required.
- C. Where equipment is furnished by others, verify dimensions and the correct locations of this equipment before proceeding with the roughing-in of connections.
- D. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any work, carefully check and verify all dimensions, sizes, etc. with the drawings to see that the equipment will fit into the spaces provided without violation of applicable codes.
- E. Should any changes to the Work indicated on the Drawings or described in the Specifications be necessary in order to comply with the above requirements, notify the College immediately and cease work on all parts of the contract which are affected until approval for any required modifications to the construction has been obtained from the College.
- F. Be responsible for any cooperative work which must be altered due to lack of proper supervision or failure to make proper provisions in time. Such changes shall be under direction of the Engineer and shall be made to his satisfaction.
- G. Perform all Work with competent and skilled personnel.
- H. All work, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.

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- I. Replace or repair, without additional compensation, any work which, in the opinion of the Engineer, does not comply with these requirements.

END OF SECTION

SECTION ~~233000~~-15800 – HEATING, VENTILATING AND AIR CONDITIONING

SECTION 15800 – HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

A. DESCRIPTION

1. This section includes low and medium pressure ductwork and fittings, air distribution, mechanical piping systems.
2. Refer to drawings for equipment specifications.

B. QUALITY ASSURANCE

1. References: This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

a.	ASTM A36-91	Structural Steel.
b.	ASTM A90-81 Articles.	Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel
c.	ASTM A167-92b Sheet and Strip.	Stainless and Heat-Resisting Chromium-Nickel Steel Plate,
d.	ASTM A525-91 (Galvanized) by the Hot-Dip Process.	General Requirements for Steel Sheet, Zinc- Coated
e.	ASTM A527-90 Lock Forming Quality.	Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process,
f.	NFPA 90A-93	Installation of Air Conditioning and Ventilating Systems.
g.	NFPA 90B-93	Installation of Warm Air Heating and Air Conditioning Systems.
h.	NFPA 91-92 Vapor Removal or Conveying.	Installation of Blower and Exhaust Systems for Dust, Stock and
i.	SMACNA ADLTM-85	HVAC Air Duct Leakage Test Manual.
j.	SMACNA DCS-85	HVAC Duct Construction Standards - Metal and Flexible.
k.	CMC	California Mechanical Code
2. No variation of duct configuration or sizes permitted except by written permission. Upon written permission size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.
3. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
4. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
5. Installer: Company specializing in performing the work of this section with minimum five years documented experience.

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6. Construct ductwork to NFPA 90A&B standards. Duct gauges shall conform to CAC Title 24 UMC unless otherwise specified in this section.
7. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

1.2 SUBMITTALS

- A. Submit the following product data under provisions of section 230500:
 1. Mechanical equipment including fans, air handlers, chiller, pumps, boiler, expansion tanks, VFD's
 2. Air diffusers and grilles
 3. Ductwork and ductwork specialties including dampers
 4. Mechanical piping including pipe, fittings, insulation, hangers and supports, valves, and piping appurtenances
 5. Flues

1.3 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 230500.
- B. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Supply and General Exhaust: Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet G-90 or better, lock-forming quality, chem treat or oil coat. Exterior ductwork or duct exposed to high humidity conditions (i.e. kitchen exhausts) shall be G-90 or better galvanized steel LFQ chem treat or oil coat. G90 zinc coating shall be in conformance with ASTM A90.
- B. Acoustic Type Insulated Flexible Duct: Pre-manufactured duct with galvanized steel wire helix (acoustic flex). Duct shall be pre-insulated to R8.0, UL 181 Listed, CPE liner duct permanently bonded to a coated to spring steel wire helix and supporting a fiberglass insulating blanket. Low permeability outer vapor barrier of fiberglass reinforced film laminate. Install in accordance with listing and Title 24 requirements. Support without kinks or bends. Provide minimum 3 diameters straight duct upstream of diffusers. **Note: Flex duct is only allowed and shall be provided at final connection to supply diffusers and return grills in length of 6' to 8'.** Manufacturers: Thermaflex M-KE or approved equal.
- C. Fasteners: Rivets, bolts, or sheet metal screws shall be cadmium plated. Fasteners for stainless steel ductwork shall be stainless steel.
- D. Sealant: Non-hardening, water-resistant, fire resistive, compatible with mating materials; liquid used alone or with heavy mastic.
- E. Hanger Rod: ASTM A36; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 DUCTWORK FABRICATION

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- A. All ductwork shall be constructed to meet SMACNA requirements in Section 7 of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible" 2005. Unless otherwise indicated, provide duct material, gages, reinforcing, and sealing for operating pressures indicated. Circular ducts shall be spirally seamed.
- B. Transverse Joints: Ductmate or WDCI proprietary duct connection systems will be accepted. Ductwork constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.
- C. TDC/TDF/T-24 shall be constructed as a SMACNA T-24 flange. Use of these joint systems shall be limited as follows:
 - D. Duct Size 0 - 42" Operating Pressure 0 - 2" W.G.
- E. Longitudinal Seams: Pittsburgh Lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Snaplock is not acceptable.
- F. Ductboard: Fiberglass ductboard will not be accepted.
- G. The Contractor will be required to replace proprietary duct construction and transverse joining systems that are installed without authorization.
- H. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide extended trailing edge turning vanes.
- I. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- ~~J. Fabricate continuously welded round two gages heavier than duct gages indicated in SMACNA Standard.~~
- ~~1-J.~~ Joints: 0" - 20" diameter, interior slip coupling beaded at center, fastened to duct with screws and with sealing compound applied continuously around joint before assembling and after fastening. Wrap joints with 3 inch wide foil backed tape.
- ~~2-K.~~ Joint 22" - 72" diameter, use 3 piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure bank designed to compress gasketing between internal flanges. Example: Ductmate Spiralmate or equal.
- ~~K-L.~~ Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

2.3 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufacture in accordance with SMACNA DCS, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

2.4 ACOUSTIC DUCT LINER

- A. 1" thickness (Owens Corning Type R4.2 or equal)
- B. Shall meet requirements for bacterial and fungi resistance outlined in ASTM test methods G-21, G-22 and C-1338.
- C. Install in strict accordance with manufacturer's instructions and Title 24 requirements.

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- D. Note that duct size shown is net inside dimension. Sheet metal dimensions shall be 2" larger than size shown to account for liner thickness.

2.5 DUCT INSULATION

- A. Insulate all supply and return ducts including acoustically lined ducts unless they are exposed in the space.
- B. Owens Corning "Soft R" Type 75 Duct Wrap or equal
- C. Ducts in First Floor ceiling space (indirectly conditioned):
 - 1. 1.5" thickness, R4.1 installed R-value 25% compression, FRK facing
- D. Install in strict accordance with Title 24 requirements

2.6 FLUES

- A. Schedule 40 PVC in accordance with manufacturer's instructions and UL listing.

2.7 MECHANICAL PIPING AND INSULATION SYSTEMS

- A. Heating Hot Water:
 - 1. Copper Type L, ASTM B88, w/ wrought copper fittings, lead free sweat joints.
 - 2. Pipes 2" and larger shall be brazed using 15% silver content solder.
- B. Pipe Supports:
 - 1. All component model numbers noted are Cooper B-line. Substitutions are allowed in accordance with provisions in specifications for acceptance of substitutions.
 - 2. All piping shall be seismically braced in where required by and in accordance with SMACNA Seismic Restraint Guidelines, latest edition. Braces shall be in the lateral and axial directions. Slack cable braces shall be used for hangers required to move as part of thermal expansion provisions and shall not interfere with that movement.
 - 3. All insulated piping shall be supported with the use of calcium silicate insulated pipe supports to prevent collapse of insulation except that pipes 3/4" and smaller may use adjustable clevis hanger with galvanized sheet metal shield (B-3151 or equal).
 - 4. All supports shall be manufactured of steel components. Use of plumbers tape, metal strap, plastic hangers or other types is not allowed.
 - 5. All copper pipe shall be isolated from steel hangers and supports using factory Vibra-Cushion strip or plastic coated hangers. Field wrapping of pipe with tape is not acceptable.
 - 6. Adjustable Steel Swivel Ring: Figure B-3170 or equal.
 - 7. Adjustable Steel Swivel J-hanger: Figure B-3690 or equal.
 - 8. Adjustable Steel Clevis Hangers: Figure B-3100, B-3104 or equal.
 - 9. Pipe Clamps: Figure B-200 Tubing/Pipe Clamp, Figure B-2000 Series clip-in pipe clamps

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10. Strut: B-11, B-22, and B-52, 12 gauge. Size as required for piping load and span.
11. Structural steel tubes and shapes as specified on details, fully hot-dipped galvanized after cutting and welding. Required field welds and cuts shall be coated with cold galvanizing compound.

C. Pipe Insulation:

1. Insulate heating hot water piping.
2. Insulation: Owens Corning preformed fiberglass pipe insulation w/ all-service jacket conforming to ASTM C547, thermal conductivity 0.23 Btu-in/hr-sqft-°F at 75°F. Thickness as follows:
 - a. Heating Water Supply and Return: 1.5" thickness
3. Provide white PVC one-piece pre-formed fitting covers at all fittings (tees, elbows, etc.)
4. All insulated piping installed outdoors shall be provided with waterproof sheet aluminum wrap and fully sealed rain tight with non-hardening caulk (color to match aluminum wrap).

2.8 PIPE LABELING

- A. Label all piping within mechanical room in accordance with ASME A13.1 pipe labeling standards.
- B. Labels: As manufactured by Seton or approved equal, vinyl plastic labels with pressure sensitive adhesive backing.
- C. Submit labeling scheme for review by the Engineer prior to ordering labels.
- D. Clean all piping and insulation jackets prior to application of labels.

2.9 PRESSURE GUAGES

- A. Weiss or equal.
- B. 2 1/2 dial size, Range as indicated on drawings and as required so that normal operating pressure is approximately mid-scale.
- C. Provide with gauge cock, 1/4" NPT.

2.10 THERMOMETERS

- A. Dial type, range as required for measurement of expected fluid temperature range.
- B. Weiss, 5" dial, Vari-Angle with recalibrator or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install manufactured ductwork and fittings in accordance with manufacturer's instructions.
- B. Install and seal ducts in accordance with SMACNA DCS and SMACNA HVAC Air Duct Leakage Test Manual.

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- C. Contractor shall verify all dimensions at the site, making all field measurements and shop drawings necessary for fabrication and erection of sheet metal work. Make allowances for beams, pipes and other obstructions in building construction and for Work of other Sections. Check Drawings showing Work of other trades and consult with the the University in the event of potential interference.
- D. Duct sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- H. Use double nuts and lock washers on threaded rod supports.
- I. Fabricate ductwork in a workmanlike manner with airtight joints, presenting smooth surfaces on inside, neatly finished on outside, construct with curves, bends, turning vanes to aid the easy flow of air.
- J. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- K. All exposed ductwork and supports shall be primed and painted. All ductwork shall be considered exposed unless concealed in shafts or ceiling spaces. Color to be selected by the College.
- L. Provide manual volume damper with locking quadrant at all branch take-offs to diffusers and grills whether shown on plans or not.

3.2 SCHEDULES

A. DUCTWORK MATERIAL SCHEDULE

<u>AIR SYSTEM</u>	<u>MATERIAL</u>
1. Supply	Galvanized Steel
2. Return	Galvanized Steel
3. General Exhaust	Galvanized Steel

END OF SECTION

SECTION 16010 – ELECTRICAL GENERAL PROVISIONS

SECTION 16010 – ELECTRICAL GENERAL PROVISIONS

PART 1 GENERAL

1.01 DEFINITIONS (APPLICABLE TO DRAWINGS AND SPECIFICATIONS)

Above Grade:	Not buried in ground and not embedded in concrete slab on ground.
Below Grade:	Buried in ground or embedded in concrete slab in ground.
Concealed:	Inside building above grade and located within walls, furred spaces, crawl spaces, attic and above suspended ceilings, etc. In general, any item not visible or directly accessible.
Connect:	Complete hookup of item with required services, including conduit, wires and other accessories.
Exposed:	Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms. In general, any item that is directly accessible without removing panels, walls, ceiling or other parts of structure.
Furnish:	Supply and deliver complete.
Install:	Place, secure and connect as required to make fully operational.
Provide:	Furnish and install as defined above; perform work.
Underground:	Buried in ground, including under building slabs.
Use (verb):	Furnish and install as defined above.
Wiring:	Electrical raceway, conductor and connection.

1.02 SCOPE OF WORK

- A. Furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on the drawings and/or specified and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete installation, including all accessories and appurtenances required for testing the system. It is the intent of the drawings and specifications that all systems be complete and ready for operation. Paint all exposed raceways to match adjacent surfaces.

1.03 CODE COMPLIANCE

- A. All work and materials shall comply with the latest rules, codes and regulations, including, but not limited to the following:
 - 1. Occupational Safety and Health Act Standards (OSHA).
 - 2. NFPA #70: National Electric Code (NEC).
 - 3. NFPA #72: National Fire Alarm Code
 - 4. NFPA #101: Life Safety Code.
 - 5. All other applicable Federal, State and Local laws and regulations.
- B. Code compliance is mandatory. Nothing in these Drawings and Specifications permits work not conforming to these codes. Where work is shown to exceed minimum code requirements, comply with Drawings and Specifications.
- C. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, the Contractor shall be responsible for all work required to open and restore the concealed areas in addition to all required modifications.

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1.04 CONDITIONS AT SITE

- A. Visit to site is required of all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
- B. Lines of other services that are damaged as a result of this work shall promptly be repaired at no expense to the Owner to complete satisfaction of the Owner's Representative.

1.05 DRAWINGS AND SPECIFICATIONS

- A. All Drawings and all Divisions of these specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.
- B. The Contract Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assured. Exact requirements shall be governed by Owner's representative, structural and mechanical conditions of the job. Consult all other Drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.
- C. Right is reserved to make change up to ten feet in location of any outlet or equipment prior to roughing-in without increasing contract cost.
- D. Equipment and fixtures shall be connected to provide circuit continuity in accordance with applicable codes, whether or not each piece of conductor, conduit or protective device is shown between items of equipment or fixtures and the point of circuit origin.

1.06 SAFETY AND INDEMNITY

- A. No act, service, drawing review or construction review by Owner, the Owner's representative, the Engineers, or their Consultants, is intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

1.07 RECORD DRAWINGS

- A. Contractor shall obtain a complete record set of reproducible transparencies from the Owner's representative. This shall be corrected daily to show all changes from original contract drawings and shall be kept on the job. This set of reproducibles, clearly and neatly marked, shall be delivered to the Owner's representative upon completion of the job.

PART 2: PRODUCTS

2.01 MATERIAL APPROVAL

- A. All materials must be new and bear Underwriters' Laboratories label. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency.
- B. Material not in accordance with these specifications may be rejected either before or after installation.

2.02 SUBSTITUTION

- A. All substitutions shall be subject to Engineer's and Owner's approval.

SECTION 16010 – ELECTRICAL GENERAL PROVISIONS

2.03 SUBMITTALS

A. Submittals required as follows:

1. Materials List: Identifying information covering all electrical materials.

2.04 OPERATING AND MAINTENANCE MATERIAL

A. Submit Operating and Maintenance Manuals of all equipment. Verify exact quantity with Owner's representative.

2.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver and handle materials in a manner to prevent damage.
- B. Store and protect equipment from weather and dampness.

PART 3: EXECUTION

3.01 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

- A. Only quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.
- B. Provide foreman in charge of this work at all times.

3.02 COORDINATION

- A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under other trades that require electrical connections. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.
- B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work.

3.03 CUTTING AND PATCHING

A. See General Conditions

3.04 EXCAVATION AND BACKFILL

- A. All excavation and backfill required because of this work shall be included. Trenches shall be cut straight and true and shall be shored and braced where required. Shoring shall comply with Section 01060. Filling and compaction shall comply with Section 02200 Earthwork.

3.05 EXISTING UNDERGROUND UTILITIES AND SERVICES

- A. Locations of existing utilities, where shown, were established from best possible information. Assume that this information is approximate. Contractor shall verify exact locations and depths before starting work. Should, during the course of the work, conditions arise that indicate conditions are other than indicated, notify Owner's representative immediately. Use extreme caution so as not to damage or break lines that are in use. If breakage does occur, Contractor shall be responsible for all damage

SECTION 16010 – ELECTRICAL GENERAL PROVISIONS

and repairs resulting therefrom. All unusual conditions with respect to existing facilities shall be brought to Owner's representative's attention immediately. See Division I, General Provisions.

3.06 CONNECTIONS TO EXISTING WORK

- A. Install new work and connect to existing work with minimum interference to existing facilities. All existing service interruptions shall be held to a minimum. Interruptions must be scheduled in advance with Owner to suit his convenience. Duration of interruptions shall be as agreed with Owner's representative. Owner reserves the right to require that necessary interruptions be at times other than usual business hours. Contractor shall follow the approved work phasing sequence as directed by the Owner's representative. Maintain continuous operations of existing facilities as required with necessary temporary connections between new and existing work. Restore existing disturbed work to original condition, including maintenance of wiring continuity as required.

3.07 ACCEPTANCE DEMONSTRATION

- A. Upon completion of work, at a time to be designated by the Owner's representative, the Contractor shall demonstrate for the Owner the operation of the electrical installation, including any and all special items installed by him or installed under his supervision.

3.08 FIELD TEST AND OPERATIONAL CHECK

- A. Arrangements for a final test and inspection of completed systems by the Owner's representative shall include:
 - 1. Demonstration that all systems, circuits, lights and equipment operate satisfactorily and as called for, with fixtures and equipment/devices connected.
 - 2. Spot check verification of color coding, tagging, numbering and splice make up.

END OF SECTION

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

SECTION 16050 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1: GENERAL

1.01 CONDITIONS AND REQUIREMENTS

- A. Refer to Section 26 01 10 - Electrical General Provisions.

1.02 DESCRIPTION

- A. Work included in this Section is conduits, wires and other miscellaneous materials not specifically mentioned in other Sections of DivisionS 26 and 28, but necessary or required for equipment or system operation or function, and the labor to install them.
- B. Related work: Other Sections of DivisionS 26 and 28.

PART 2: PRODUCTS

2.01 CONDUITS AND OTHER RACEWAYS

- A. Rigid Steel: Hot-dipped galvanized or sherardized.
- B. Intermediate Metal Conduit (IMC): Electro-galvanized or sherardized.
- C. Electrical Metal Tubing (EMT): Electro-galvanized or sherardized.
- D. Plastic: Schedule 40 PVC, approved for use as non-metallic raceway for 90 degree C. conductors. Carlon, CertainTeed or Kalroy., or equal.
- E. Wireway (gutter): Code gauge steel, with knockouts and hinged cover. Corrosion resistant gray baked enamel finish.
- F. Provide fittings and accessories approved for the purpose equal in all respects to the conduit or raceway. EMT connectors and couplings shall be steel compression type.
- G. Surface Raceway: Wiremold non-metallic raceway system per plans. Verify finish with Owner.

2.02 WIRES AND CABLES

- A. For power and lighting systems 600V or less:
 - 1. Conductor: #12 and #10 AWG solid copper. #8 AWG and larger shall be stranded copper.
 - 2. Insulation type: #12 to #1 AWG shall be THWN for wet or underground locations and THHN for dry locations. Grounding wire shall be type THWN.
 - 3. Minimum Conductor Size:
 - a. Minimum size: #12 AWG for 120/208V circuit runs less than 100 feet
 - b. Runs over 100 feet for 120/208V system shall be #10 AWG or larger as directed by NEC Voltage Drop Restrictions.
 - c. Underground circuits shall use #10 AWG minimum wires unless otherwise noted.
 - 4. Aerial Conductor: Thermoplastic insulated Type THW-2 copper.
- B. Acceptable Products: General Electric, Anaconda, Okonite, Paranite, Pirelli-General, Triangle, or equal products conforming to or exceeding applicable IPCEA standards.

2.03 OUTLET BOXES, JUNCTION BOXES AND PULL BOXES

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

- A. Outlet boxes: Hot-dipped, galvanized or sherardized of required size, 4" square, minimum, for flush mounted devices and lighting fixtures. Cast type with gasketed covers for outdoors or wet locations.
- B. Junction and pull boxes: Use outlet boxes with appropriate covers as junction boxes wherever possible. Larger junction and pull boxes shall be fabricated from sheet steel, sized according to code, with screw-on covers, finished gray baked enamel.

2.04 CONDUIT HANGERS

- A. For individual conduit runs not directly fastened to the structure, use rod hangers manufactured by Caddy, Unistrut, Powerstrut or equal.
- B. For multiple conduit runs, use Unistrut, Powerstrut, or equal trapeze type conduit support designed for maximum deflection not greater than 1/8".

2.05 WIRE CONNECTORS

- A. For wires size #8 AWG and smaller: Insulated pressure type (with live spring) rated 105 degrees C., 600V for building wiring and 1000V in signs or fixtures. Scotchlok, Ideal, or equal.
- B. For wires size #6 AWG and larger: T&B or equivalent compression type with 3M #33+ or Plymouth "Slipknot Grey" tape insulation or equal.

2.06 GROUNDING

- A. Ground wire shall be medium hard drawn copper conductor, stranded, bare, minimum sizes per NEC unless larger conductors are shown on drawings.
- B. Bond ground rod(s) to metal underground cold water pipe, building structural metal columns, and/or concrete - encased electrodes with #4/0 bare copper ground wire to form a ground electrode system.
- C. Unless otherwise noted on drawings, provide green insulated copper ground wire in all feeders and circuits connected to motors, equipment, exterior lighting fixtures, GFI receptacles, in feeders/circuits using non-metallic conduits. Size ground wire per NEC unless otherwise shown.

PART 3: EXECUTION

3.01 GENERAL

- A. Electric system layouts indicated on the drawings are generally diagrammatic, but shall be followed closely as actual construction and work of other trades will permit. Govern exact routing of cable and wiring and the locations of outlets by the structure and equipment served. Take all dimensions from Owner's representative drawings.
- B. Consult all other drawings. Verify scales and report any dimensional discrepancies or other conflicts to Owner's representative before submitting bid.
- C. All home runs to panelboards are indicated as starting from the outlet nearest the panel and continuing in the general direction of that panel. Continue such circuits to the panel as though the routes were completely indicated. Terminate home- runs of signal, alarm and communications systems in a similar manner.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of Owner's representative and conform to all structural requirements when cutting or boring the structure is necessary and permitted.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing runners, etc., required for equipment specified under this Section.
- F. Provide necessary backing required to insure rigid mounting of outlet boxes.

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

3.02 WIRING METHOD

- A. Install all wiring in raceway, unless specifically shown otherwise.
- B. Minimum conduit size shall be 1/2" when installed above ground and 3/4" when installed underground or under building slabs. Increase conduit size as required for wiring. Size for conduit, unless specifically shown otherwise, shall be determined from Table 3A for conductors #16 through #4/ AWG and Table 3C for conductors 250 MCM or larger, Chapter 9 of latest National Electrical Code.
- C. Conduit shall be rigid steel, IMC, EMT or plastic as follows:
 - 1. Above ground: Use rigid steel, EMT or IMC only.
 - a. Wet locations: Rigid steel or IMC only.
 - b. Hazardous locations: Rigid steel conforming to NEC requirements.
 - c. Locations subject to mechanical injury: Rigid steel or IMC only.
 - d. In concrete walls or block walls: Rigid steel only or IMC only.
 - e. Dry locations and not subject to mechanical injury: EMT, IMC or rigid steel conduit.
 - 2. Underground: Use rigid steel or plastic.
 - a. Underground conduits shall be installed as specified on trench detail on plans. Multiple runs shall maintain 3" minimum separation between runs. Contractor shall maintain minimum burial depth.
 - 3. Make all risers to grade with rigid steel conduit and rigid steel elbow fittings only.
 - 4. Burial depth of conduits shall be as follows:
 - a. Concrete encased: 24" minimum for 600V or lower systems to top of concrete encasement.
 - b. Concrete capped: 24" minimum to top of conduit.
 - c. Conduits without concrete encasement or cap: 24" minimum to top of conduit.
 - d. When installed under buildings the above minimum depth shall be 18" below bottom of floor slab.
- D. Use flexible conduits in the following applications:
 - 1. Recessed lighting fixtures .
 - 2. Motor connections.
 - 3. At expansion joints.
 - 4. At wet locations, flexible conduit shall be liquid tight type.
- E. Provide all junction boxes/pull boxes as required to limit any power system conduit run to a maximum of four 90 degree bends (two 90 degree bends for telephone conduit run) or to avoid "U" bends.

3.03 INSTALLATION OF CONDUITS

- A. General:
 - 1. Run all conduits concealed unless otherwise noted or shown.
 - 2. Run exposed conduit parallel to or at right angles to center lines of columns and beams.
 - 3. Run no conduit in concrete slabs or floors except at point of penetration. All penetrations shall be at right angles to slab surfaces.
 - 4. Install conduits above ceilings to avoid obstructing removal of ceiling tiles, lighting fixtures, air diffusers, etc.
 - 5. Conduits shall not cross any duct shaft or area designated as future duct shaft horizontally. Conduit rises when allowed in duct shaft must be coordinated with Mechanical work to avoid any conflict.
- B. Conduit Supports:
 - 1. Support conduits with Underwriters' Laboratories listed steel conduit support intervals required by the National Electric Code. Wires or sheet metal strips are not acceptable for conduit support. Use conduit hangers for all conduits not directly fastened to structure and for all multiple conduit runs.

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

- 2. Individual conduits 1/2" and 3/4" size may be supported from ceiling support wires with Caddy clips only if acceptable to local code. Only one conduit is permitted to be attached to any ceiling support wire. Hang such conduit so as not to affect level of ceiling.
- 3. Avoid attaching conduit to fan plenums. When it is necessary to support conduit from fan plenum, provide a length of flexible conduit between portion attached to the fan plenum and portion attached to the building to minimize transmission of vibration to the building structure.
- C. Conduit Penetrations Conduit penetrations of roof, walls, floors and ceilings shall be sealed to preserve the integrity of waterproofing, fire rating and soundproofing for which the roof, wall, floor or ceiling is designed. Materials and methods used shall conform to that specified under Owner's General Sections.
- D. All underground conduits and ducts 2" and larger shall be proven clear by pulling through a mandrel 1/4" smaller than the inside diameter.
- E. Where flush branch circuit panelboards or terminal cabinets are shown on walls, stub a minimum of four 1" empty conduits into overhead ceiling spaces and four 1" empty conduits into space below floors (if any) in addition to conduits required for circuit wiring.
- F. All exposed raceways shall be prime painted and finished to match adjacent surfaces unless otherwise directed by owner.

3.04 INSTALLATION OF WIRES

- A. Pull no wire into any portion of the conduit system until all construction work which may damage the wire has been completed.
- B. Install all wire continuous from outlet to outlet or terminal to terminal. Splices in cables when required shall be made in handholes, pull boxes or junction boxes. Make branch circuit splices in outlet boxes with 8" of correctly color-code tails left in the box.
- C. Splices in wires and cables shall be made utilizing materials and methods described hereinbefore.
- D. All cables and wires passing through manholes and handholes shall be full looped inside the manhole and handhole and supported on galvanized steel racks.
- E. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to ground terminal of devices when the device is not approved for grounding through the mounting screws.
- F. Provide Brady wire markers where number of conductors in a box exceeds four.

3.05 WIRE COLOR CODE

- A. Color code all conductors. Wire sizes #8 AWG and smaller shall have integral color coded insulation. Wire sizes #6 AWG and larger may have black insulation but identified by color coded electrical tape at all junction, splice, pull or termination points. Color tape shall be applied 1/2 lap to at least 6" of the conductor.
- B. Color code wires as follows:

Conductors	120/208V
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green

3.06 CONNECTIONS TO EQUIPMENT

- A. General

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

1. Furnish and install required power supply conduit and wiring to all equipment. See below for other wiring required.
 2. Furnish and install a disconnect switch immediately ahead of and adjacent to each magnetic motor starter or appliance unless the motor or appliance is located adjacent and within sight of the serving panelboard, circuit breaker or switch. Verify all equipment nameplate current ratings prior to installation.
 3. Mount all motor starters and provide all power wiring to them, including those furnished under other Sections or specifications.
 4. Install all rough-in work for equipment from approved shop drawings to suit the specific requirements of the equipment.
 5. Furnish and install all magnetic motor starters that are shown on the electrical drawings or specified under other Divisions to be furnished under this Division of work. Verify equipment nameplate ratings prior to installation and furnish adequately rated starters for the loads.
 6. Furnish and install manual thermal protection for all motors not integrally equipped with thermal protection.
 7. Furnish 120V power to each control panel and time clock requiring a source of power to operate.
- B. Other Contract-Furnished and/or Owner- Furnished Equipment
1. All required power and control conduit, wiring and connections are included under this Section of the work. Control sensing and alarm devices will be furnished under the respective Section of the contract supplying the equipment unless noted otherwise. Where these are located in pipes, ducts, vessels, tanks, etc., they will be mounted in a place by the Contractor furnished the devices. All others shall be mounted under this Section of the work.

3.07 IDENTIFICATION

- A. Provide engraved, lamacoid screw fastened nameplates for panels, motor starters, disconnect switches and all similar devices.
- B. Provide dymo labels on all lighting switches and convenience and special purpose receptacles to show panel and circuit number to which the device is connected.
- C. Provide label on all motors: "Caution, Automatic Equipment. May start at any time."

3.08 UTILITY SHUTDOWN

- A. Contractor shall inform the Owner of any system or power shutdown required at least five (5) days prior to shut down.

END OF SECTION

SECTION 17000 – BUILDING MANAGEMENT SYSTEMS

DIVISION 17000 - BUILDING MANAGEMENT SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

- A. The General Conditions and requirements and section 15050 (Basic Mechanical Requirements) are hereby a part of this section as fully as if repeated herein.

1.2 SCOPE

- A. This section contains specifications pertaining to the modification of existing Building Management System (BMS) equipment for control of all HVAC equipment as specified herein and on contract drawings.
- B. The scope of work for this project shall specifically include all necessary ancillary equipment, materials, components, programming, commissioning, trending and labor as required to provide a complete and operational system as described in the sequence of operations on the drawings whether or not those components are specified herein or on contract drawings.
- C. Project intent is that existing Siemens controls be replaced with new Tridium based BMS system compatible with existing campus systems (Trane or Johnson only- see section 1.4.D). Existing sensors, field devices and wiring may be reused to the extent that they are compatible with new systems.
- D. Refer to drawings including controls notes on sheet M0.1 for complete description of scope and sequence of operation.

1.3 RELATED GUIDELINES

- A. See Division 16 Electrical specifications for requirements pertaining to basic Electrical Methods and Materials
- B. Standards: Comply with applicable provision of the following standards, latest editions, except as otherwise shown or specified.
 - 1. ARI Air Conditioning and Refrigeration Institute
 - 2. ASHRAE 85 Automatic Control Terminology for Heating, Ventilating, Air Conditioning.
 - 3. ASME MC85.1 Terminology for Automatic Control
 - 4. FM Factory Mutual Insurance Companies
 - 5. IEEE Institute of Electrical and Electronic Engineer's local area networking standards and architectures (i.e. IEEE 802.3, IEEE 802.5).
 - 6. IRA/FIA Industrial Risk Insurers
 - 7. ISA Instrument Society of America
 - 8. JIC Joint Industrial Council
 - 9. MSS Manufacturer's Standardization Society
 - 10. NEMA EMC1 Energy Management Systems Definitions

SECTION 17000 – BUILDING MANAGEMENT SYSTEMS

11. NSC National Safety Council

1.4 SYSTEM COMPATIBILITY

- A. All new BMS controllers, components and programs shall be fully compatible with existing campus BMS systems (Trane and Johnson only):
- B. The Building Management System (BAS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.
- C. System shall be web based and graphics shall reside on the existing Campus virtual Tridium server. Trending shall all be stored on the virtual Tridium server and shall utilize Facilities Explorer (FX) software. Prior to bid Contractor shall investigate server and confirm compatibility with proposed BMS system.
- D. System shall be:
 - 1. Johnson Controls FX-20/60/70 Web (Tridium) based front end with Johnson Controls devices and controllers. BACnet drivers shall reside in controller and Open licensing shall be included in each FX device. Programming of the FX-20/60/70 and creating all required dynamic graphics shall be included in this section.
 - 2. Trane Building Logix System (Tridium Based) with full web access.

1.5 BASIC BMS CONSIDERATIONS

- A. As part of this project, contractor shall provide complete access to all new building control programs and routines via interactive web based graphics screens accessible over the internet.
- B. The College shall provide a data jack in close proximity to the proposed building controller installation location. The College shall also provide the required static I/P address for the new building controller as required. Contractor shall coordinate closely with the campus I/T department and provide a minimum of 6 weeks between the time the I/P address is requested and when it is required for system operation.
- C. Panel Locations: BMS panels should be under cover and centrally located relative to controlled equipment. BMS panels shall be protected from pipe leakage, dust, and other hazards and shall have a minimum 36" working clearance in front of each panel. Refer to drawings for locations of BMS panels. The exact panel location will be determined by the Contractor and the College Representative prior to the installation process.
- D. Power to Panels: Provide new or reuse existing dedicated power circuit to power each controller or group of controllers.
- E. HOA Switches at Motor Starters: Tie into new and existing motor starters as required. Starters shall be provided with HOA switches.
- F. Interface Relays: BMS output points shall not be used for direct switching of motor control circuits. Provide an interface relay with 24 VAC coil at the motor starter panel.
- G. Status Monitoring: Electric current sensor switches shall be used for BMS status monitoring of fans with the exception of furnaces (as opposed to differential pressure switches or flow switches). These shall be located in the motor starter panel.
- H. Start-Up Testing (Commissioning):

SECTION 17000 – BUILDING MANAGEMENT SYSTEMS

1. All BMS installations shall be commissioned as covered under start-up testing in this specification. In this testing, each control point and sequence of operation shall be verified for proper operation. The Contractor shall include BMS start-up testing in the construction schedule.
- I. System Expansion Capability:
 1. System Point Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers or expansion modules (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The PC operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.
 2. System shall be modular to allow change of function and operation in the field by plug-in-modules, equipment and software changes to expand system capacity without interrupting system operation.

1.6 SUBMITTALS

- A. The Contractor shall submit the following information on materials, components, and sequence of operation, diagrams, and acceptance testing. Refer to section 230500 and General Conditions for submittal format and procedural requirements, unless otherwise specified in the following sections:
 1. Material Submittal
 - a. For all components/hardware and materials: Submit catalog cuts, technical specification data sheets, description of function, performance data, materials of construction, manufacturers' installation instructions, wiring diagrams, etc. as required to show full compliance with contract requirements.
 - b. For all installation materials to panel enclosures, mounting hardware, wiring and raceways submit catalog cuts, technical specification data sheets, performance data, materials of construction, manufacturers installation instructions, etc. as required to show full compliance with Contract requirements.
 2. Shop Drawing Submittal/Installation Drawing Submittal and As-Built drawings:
 - a. The contractor shall provide detailed, job-specific wiring diagrams. Generic wiring diagrams will not be acceptable. Diagrams shall incorporate the existing components to be reused as well as any new hardware, sensors, actuators and controllers, including other electrical components to complete the specified scope of work. Schematics shall include labeling of terminal strip connection points and of wiring cables. A copy of the wiring diagram is to be provided to and reviewed by the College and the Engineer prior to the starting of any fieldwork. The contractor shall make any and all changes requested by the Engineer and resubmit for approval as required.
 - b. Upon completion of the field work the contractor shall provide the updated installation drawings. Once the installation drawings have been given to the College, the acceptance testing, commissioning and training schedule may be set.
 - c. Upon completion of the acceptance testing, commissioning, and training the contractor will have fourteen (14) days to provide As-built drawings for the project. The project closeout will not be completed until the College has receipt of the final drawings.
 3. Software and Graphics Screens

SECTION 17000 – BUILDING MANAGEMENT SYSTEMS

- a. As part of the submittal process, contractor shall submit for College and Engineer's review sample graphics screens to be provided for the project. Graphics screens shall match in general appearance and information displayed the existing screens set up for similar buildings at Cabrillo College. These screens shall be made available by the college to the contractor for viewing. Additional display information or changes to the proposed screens requested by the College or the Engineer shall be made by the contractor at no additional charge to the College.

1.7 POINTS LIST

- 1. Refer to controls diagrams on drawings for complete information on required minimum control points.
- 2. Provide any and all additional points (actual or virtual) as required to allow for system functionality and compliance with the sequence of operation as no added cost to the College.

1.8 SEQUENCE OF OPERATION

A. GENERAL

- 1. See project drawings for required sequence of operation for all systems.
- 2. The sequences of operation described on the drawings cover general requirements. These sequences do not necessarily cover all software features necessary for stable control or operation of equipment without damage. The contractor shall be responsible for providing all additional software features (time delays, PID loops, etc.) as may be required for stable control and to operate controlled equipment consistent with equipment manufacturer's recommendations.
- 3. All software to be installed in the controllers shall be tested prior to field installation using simulation mode testing software. Such testing shall be demonstrated to the satisfaction of the College at the request of the College.

PART 2 - PRODUCTS

2.1 CONTROLLERS

A. Building Controller:

- 1. Provide standalone, microprocessor based Building Controller to manage all local controllers and building control functions.
- 2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
- 3. The controller shall provide a communications port for connection of the Portable Operators Terminal.
- 4. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
- 5. Controllers that perform scheduling shall have a real time clock.
- 6. Data shall be capable of being shared between networked Building Controllers.

SECTION 17000 – BUILDING MANAGEMENT SYSTEMS

7. The Building Controller shall utilize industry recognized BACNET open standard protocols for communication to unit controllers and to the internet.
 8. The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
 - c. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
 - d. Automatically reset the Building Controller to return to a normal operating mode.
- B. Local Controllers:
1. Provide local equipment specific controllers and unitary controllers as required for control of all building equipment as specified in the drawings.
 2. Each air handler / fancoil shall have a dedicated local controller.
 3. Controller shall be fully licensed and configured to allow modification by the end user and any contractor designated by the end user.
 4. Field configurable and programmable for control, input and output functions.
 5. 24 VAC power supply
 6. Real time clock
 7. Inputs and outputs as required to meet the points list and sequence of operation as indicated on the drawings.
 8. Local controllers shall be fully capable of stand alone operation upon loss of communication to the building controller.
- C. Control Panel and Enclosure:
1. Provide all required power, input, output and communications modules as required by schematic drawings and sequence of operation. Indoor panels shall be NEMA 1 enclosure provided specifically for the controller. Panel shall be constructed of stamped and coated steel and provided with a locking hinged door. Two keys shall be provided to College for each panel. Outdoor panels shall be NEMA 3R.
 2. All points in the controller shall be wired out to external wiring terminals. All housings and components shall be mounted inside larger overall cabinets. This includes local controllers and building controllers.
 3. Provide miscellaneous panel components and hardware as required for a fully complete and fully functional panel including; power disconnect switches, control transformer, terminal strips, raceways (Panduit or equal).
 4. Each panel shall be provided with a duplex 120-volt convenience outlet inside the panel.

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5. Each panel shall be equipped with a line voltage switch and fuses which will shut down and isolate the 120-volt power to all transformers, power supplies, and receptacles within the panel.
6. Control transformers within panels shall be individually fused. Fuses shall be readily accessible and mounted in blocks fastened to the enclosure.

2.2 BMS CONTROL WIRING

- A. The contractor shall provide the following:
 1. Low and Line voltage wiring control wiring not indicated on electrical drawings or specifically excluded below as required for a complete and fully functional control system including wiring for field devices, data bus wiring, interlock wiring for fans, sensors, control power source to BMS panel and all other field devices as needed.
 2. All wiring in all areas shall be in raceways or conduit. Installation of raceways and conduit shall be in accordance with Division 16 electrical specifications. Conduit not required for low voltage wiring concealed in walls.
 3. No splices will be allowed except at junction boxes and control centers
 4. No two (2) wires of the same color shall be in one conduit unless all wires of the same color are tagged at both ends and at any splice points.
 5. Wiring as recommended by manufacturer. Provide a consistent color scheme throughout the installed system. Alternate colors will be accepted, provided there is consistency in the system. Shielding of cables, not specifically called out below, shall be in accordance with manufactures recommendations and as determined by site conditions
 6. For motor controls wiring within starter panels, and electrical hardware interlocks to remote devices, refer to Division 16 Electrical (campus standards).

2.3 EMS INPUT POINT FIELD DEVICES

- A. Temperature Sensors:
 1. Interior space temperature sensors shall be 20K negative temperature coefficient with cover, user adjustability of heating and cooling setpoints, room temperature indication, timed override button.
 2. Outdoor air temperature sensors shall be 20K negative coefficient with 9" stainless steel probe mounted on a weatherproof handi-box. .
 3. Duct Sensors: Provide averaging type where indicated on plans and control diagrams.
- B. Command Relay-Current Switch:
 1. Current transformer, current switches and command relays used to remotely start/stop and sense status of electric motors shall be: solid state, self powered, with NO/NC contacts and adjustable amp set point, rated for the intended load. The device shall be mounted in the motor starter enclosure. Hawkeye H-608 or equal. Field adjust amp set point to detect motor operation. For belt driven motors field adjust amp set point to detect the difference between motor operation with and without the fan belt installed.

2.4 EMS OUTPUT POINT FIELD DEVICES

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A. Output Isolation Relays

1. DDC panel's outputs shall not be used for directly switching motor starter control power, or voltages greater than 24 VAC. Digital inputs and outputs controlling these types of points shall only switch local 24 VAC, within the panel. The intent is to protect the panels' power supply and I/O terminals, depending on the controller being used, from accidental contact with higher voltages in the field. All such outputs shall be protected by isolation relays and one independent low voltage power supply mounted remotely from the DDC panel. For motors, isolation relays and the independent relay power supply shall be mounted in an auxiliary panel adjacent to the DDC panel. The independent relay power supply will be provided and will either switch another low voltage relay within the starter enclosure for the motor being controlled or will switch the motor itself.
2. Output isolation relays shall be plug-in type double pole, double throw, with base indicator light, 24 volt coil, and 10 amp rated contacts; UL recognized, IDEC RH Series or equal

PART 3 - EXECUTION

2.5 EMS WIRING INSTALLATION AND TERMINATION

- A. Installation of conduit, wire, sleeves, outlet boxes, insulating bushings, systems cabinets, terminal boxes, pull boxes, junction boxes, inserts, anchors, and system devices, etc. shall be in accordance with the appropriate requirements of Division 26, Electrical.
- B. Installation of sensors wiring in finished areas shall be concealed. Where concealed wiring is not possible, written approval from the College for exposed in suitable raceway work shall be obtained prior to installation.
- C. Termination: wires shall be attached to screw terminals with non-insulated ring lug connectors except that spade lugs may be used on terminals with captive screws. Lugs shall be installed by the use of a mil spec. crimping tool specifically designed by the manufacturer for use with the lugs being installed.
- D. Wiring within the BMS and remote panels shall be executed as follows:
 1. All wiring shall be landed on labeled terminal strip with screw down lugs. Separate terminal strips shall be provided for line voltage connections, analog inputs, digital inputs, analog outputs, digital outputs.
 2. All wiring within panels shall be neatly run at right angles to enclosure sides. Wiring shall be routed so as not to pass in front of panel components. Low voltage wiring inside the panels shall be run in plastic raceways (Panduit or equal)
 3. Individual control wire conductor pairs shall be labeled on the insulation jacket for the pair at a point near the terminal strip termination. The labeling scheme shall be the same as used at the field devices.
 4. Spare conductor pairs shall be labeled as spare and to what location they are run. Spare conductors shall be neatly coiled inside the panel.
 5. Low voltage connections to temperature sensors with extended leads shall be soldered and covered with heat shrink insulation. Leads shall be fully extended per manufacturer's directions. Initial EMS hardware installation, the contractor shall be responsible for the calibration.

2.6 IDENTIFICATION

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- A. Mounting and control devices shall have identification means attached to or painted on the front or most visible surface.
- B. Nameplates and instrument tags shall be permanently attached to the field equipment. Tags wired or chained to the instrument are not acceptable for items inside of the control panels. Nameplates or tags shall be visible from the walkway or access point nearest the instrument when the instrument is in its installed configuration. Nameplates on the interior of a panel shall be placed near the instrument and shall not be obscured by the instrument or panel wiring. The nameplates on the inside or outside of panels shall be attached to the panel by self-tapping screws.
- C. Labels and label material for devices shall be submitted to the College for approval. This shall include but not limited to:
 - 1. Devices: milled laminated plates secured with epoxy cement.
 - 2. Abbreviated words and numerals shall identify the system controlled, the function and the designator, which appears on the control diagram, which is furnished by the control manufacturer and framed under glass.
 - 3. BMS input-output points shall be identified with a unique input / output address of the device.

2.7 CALIBRATION

- A. Contractor shall certify that all control devices are factory calibrated.
- B. Provide field calibration of all devices found to be problematic or not in agreement with test and balance firm's instrumentation.

2.8 CONTINUITY TESTING

- A. Verify that wiring between each end termination has continuity and is free of cross connects with other circuits. Continuity and freedom from cross connects may be accomplished over long runs by stationing personnel at either end of the particular run and using sound power phones for coordination and checking each wire pair by using a meter. The same instrument may be used to demonstrate the absence of cross connects with other wires in the cable. The wiring out shall also include the checkout of the wire marking labels for agreement with the assigned number and properly marked terminals.

2.9 TRENDING

- A. Upon completion of functional testing the Contractor shall set up and store trends of operation data showing that system is fully functional in all aspects.
- B. Trending shall be set up prior to occupancy but actual recording of trend data shall take place when the building is occupied to test actual operation under load conditions.
- C. As minimum the following trends shall be set up and results presented to the Engineer for review. Any abnormalities discovered during trending shall be investigated and corrected prior to submittal of trend data to the Engineer. Trend reports shall be submitted in summarized format (paper or pdf) and shall be accompanied by electronic data in Excel spreadsheet format. All files and reports shall be clearly indexed and labeled as to system, dates, times, variables measured, etc..
 - 1. Trend of each VAV zone at a 10 minute interval, 72 hour duration. Include the following points:
 - a. Room Temperature

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- b. Room thermostat setpoint
 - c. Zone supply air cfm
 - d. Zone supply air temperature
 - e. HW control valve position
 - f. AH unit supply air temperature
2. Trend of each zone CO2 readings (typical for two zones only)
3. Trend of air handler, relief fan and exhaust fan operation, 1 minute interval, 72 hour duration including the following points:
- a. Supply fan CFM and VFD speed
 - b. Supply air duct differential pressure
 - c. Supply air temperature
 - d. Mixed air temperature
 - e. Outside air temperature
 - f. Return air temperature
 - g. Economizer damper positions
 - h. Relief fan CFM and VFD speed
 - i. Outside air CFM
 - j. HW preheat coil valve signal
4. Trend of points described in 1 and 3 above for a typical Monday morning warm-up cycle, 1 minute interval, 1 morning warm-up cycle only.
5. Trend showing start and stop of boiler and pump systems and including hot water supply and return temperatures

2.10 ACCEPTANCE TESTING

- A. The contractor shall provide and demonstrate acceptance testing in the presence of the College's representative to demonstrate that the BMS system has been installed and tested in full compliance with the contract documents. The Contractor shall provide the College with 2 weeks advanced notice of the dates when the acceptance testing will occur.
- B. Acceptance tests shall be scheduled to begin a minimum of 2 weeks prior to the contract completion date. Acceptance testing shall be conducted only after the BMS installation is full complete, in operation, and is fully functional. Calibration, continuity testing, trending and control sequence checkout shall be completed prior to the acceptance testing.
- C. The cost of labor, materials, instruments, and supplies required for the acceptance testing will be the responsibility of the contractor, and there will not be any change to the contract amount.

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- D. Any control hardware damaged, shown to be defective during the tests or unable to perform at design or rated capacity, shall be replaced by the contractor at no additional change to the contract amount.
- E. Each acceptance testing form shall individually detail acceptance-testing procedure for each panel, and each control component and each system. Acceptance testing forms shall include check boxes for “acceptance” and “rejection” of each test including calibration documentation, continuity testing documentation, trending documentation, hardware inspection, I/O Testing and sequence of operation testing. Forms shall have a place for signatures of the College’s Representative and Contractor to certify observation of tests.
- F. Acceptance testing shall include the following tests and demonstrations as a minimum:
 - 1. Presentation of documentation showing that calibration and continuity testing has been completed.
 - 2. Presentation of trend reports covering at least 40 hours of data taken at 5 minute increments. The trend reports shall be organized by mechanical system and show the values of all inputs and outputs points. The Trends shall indicate stable control of controlled variables at set points with no appreciable hunting by controlled devices.
 - 3. Hardware walk-through inspection covering all panels and field devices.
- G. Following the above, a lap top PC and walkie-talkies shall be provided by the contractor for use during the remainder of acceptance testing. The PC shall be loaded with all required software to view system operation at each controller. The following shall be tested while logged onto each controller:
 - 1. All input sensors and devices shall be modified in the field (i.e. heat applied to sensors, wires removed, motor switched by HOA to test ct’s ect...). The change of state shall be observed at the PC logged onto the controller and confirmed via walkie-talkie.
 - 2. All outputs shall be tested by forcing a change of state at the DDC controller via the logged on PC. The change of state shall be observed at the controlled device and confirmed via walkie-talkie.
 - 3. The sequence of operation for each piece of controlled and monitored equipment shall be tested. The written sequence and program hard copy shall be reviewed line by line. Inputs associated with each sequence shall be modified to a fixed value in the controller via the PC. A change of state consistent with the sequence shall be observed at the controlled equipment and confirmed via walkie-talkie.
 - 4. As each or all tests are reviewed, an appropriate notation will be entered at the time of joint inspection on the system report with counter signature of the College’s Representative and dated. A copy of this report shall be made for the College.
- H. Where the contractor is required to modify, alter, add, or remove hardware, or software programs of the Building Management System, or related accessories for the purpose of eliminating punch list items, off-line operation and testing to implement them shall be done as required by the contractor until such time as acceptable performance of the Building Management System has been established. Problems, which occur within the accepted hardware or software, shall be corrected in an appropriate fashion under warranty. Any such occurrence may void previous approval; however, the Contractor shall be responsible to attend to and remedy such items within a reasonable time. Appropriate logs, schedules and reports shall be maintained to reflect these items and reduce their redress.

2.11 WARRANTY AND TRAINING

- A. WARRANTY

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1. Warranty, labor and materials, shall be for a period of one year from the time of a “completed” acceptance testing by the University and the Contractor.
2. The following warranty response is in addition to the requirements of Division 1. Warranty response shall include response to isolated malfunctions within (8) hours or no later than the next day (including Saturdays, Sundays, and Holidays) from when notice of malfunction by the College was given. The contractor shall however, respond within four (4) hours to any system failure which caused more than 10% of the connected data points to be inoperable or as directed by the College’s Facility Personnel as a critical situation.

B. TRAINING

1. Following acceptance testing and acceptable performance of the functioning BMS control system, the contractor to provide on-site operator instruction to the College’s personnel. This instruction is to be scheduled with 2 weeks prior notice in writing to the College. The operator instruction is to be given during normal working hours, and to be presented by a competent contractor representative. The contractor’s representative is to be familiar with the software, hardware, and accessories associated with the specific project installation.
2. The College is to be provided with (8) hours of training at the project site, for all BMS related hardware, software and accessories installed as part of the project.
3. The instruction is to be at NO cost to the College. The instruction is to include training on operation, safety, adjustment, and maintenance as it pertains to the specific components and software installed for the project. The training is to be directed to the specific project and not a “canned” training course. Operation and field adjustment hardware to be provided by the contractor at no additional cost to the College (excluding an operating computer unless otherwise noted).

2.12 PROJECT COMPLETION REQUIREMENTS

A. PROCEDURE

1. Until the documents required in this section are submitted and approved, the project will not be considered “complete” and final payment to the contractor will not be made.
2. At the time of acceptance testing the contractor shall provide one copy of completed functional testing results, 40-hour trend log, and as-built installation drawings.

B. COMPLETION DOCUMENTS

1. Operation and Maintenance Manuals (O&M) to be bound in a three ring binder, of appropriate size to allow access to all the required data, and indexed for each sections data.
2. Include copies of all submittals, product data, installation guidelines, maintenance instructions, as-built drawings, copy of software on diskette, warranty letter (including dates of warranty inception and completion), completed acceptance testing, training materials and 40-hour trend log.
3. The contractor is to provide four (4) O&M binders complete with all the required data as specified within 14 days of the College’s approval of the acceptance testing.

*** END OF SECTION ***