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BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This specification is specifically applicable to Section 23 00 00 and greater. General, Special, and Supplementary Conditions (and Requirements), and Instructions to Bidders if bound herewith (or included in an accompanying volume), apply to the work in this Section. Work of other trades included in this contract shall comply with the applicable Sections of this Specification.

B. Provide labor, equipment, and materials necessary for the installation of the work specified herein and shown on the drawings. Labor shall be performed by qualified tradesmen. Equipment and materials shall be new and of manufacturer's most recent model or type, unless otherwise specified. Each system installed under this contract shall be complete, with all accessories and safety devices, and tested to perform at design conditions.

C. Examine the drawings and specifications for this branch of the work and drawings and specifications of the other branches of work. Visit the site to become familiar with existing conditions. Attend pre-bid meetings and submit requests for clarification in writing. Read answers to requests for clarification submitted by all contractors. Submitting a bid signifies that all conditions which have a bearing in any way on the manner of providing the work are known and included in the bid.

D. Systems and equipment included in the work shall be provided such that they are complete and operable. Provide all work, including work of other trades, required to render systems and equipment complete and operable, unless such items are specifically included in the work of another contractor, as defined by the contract documents. Work of other trades shall be performed by an approved tradesman or subcontractor.

E. The roof of the boiler room has a warranty. All roof work must be performed by contractor that holds the warranty, which is Garland.

F. All work shall be complete by 1/4/13. Tie-in work may be completed after 12/14/12. All shutdowns shall be coordinated with the University at convenient times. Some shutdowns may occur after normal business hours or on weekends. Exam week is 12/10/12 – 12/14/12, which is designated as a “quiet week”. No noisy construction work may occur during this time.

G. Contractor shall conform to all provisions of his contract and is to consider the word "Contractor" or "Mechanical Contractor" to mean himself.

H. Contractor shall consult all the construction drawings to coordinate his work with that of the other contractors.
I. Any work requiring the shutting off of steam, water, etc., shall be done at such times as designated by the Owner and the Associate to interfere as little as possible with the operation of the Owner. No extra charges shall be made by the Contractor for performing such work on overtime periods.

J. Contractor shall complete his work or any part thereof at such time as may be designated by the Owner, so that it can be used for temporary or permanent use. Such use of the system shall not be construed as an acceptance of the work prior to the final written acceptance by the Owner.

K. Scope of work includes work made necessary by field conditions that are apparent during an inspection of the construction site, even though some such conditions may not be indicated in the Contract Documents.

L. Testing and Balancing and Commissioning work as specified herein shall be applied to new systems and components provided in this project, and to existing systems and components which are reused and/or modified.

1.2 CONTRACT DOCUMENTS

A. The drawings are diagrammatic representations of the work. Do not scale the drawings to determine exact locations, distances, or sizes. Take field measurements to make these determinations.

B. In drawing notes and specifications, the following definitions apply:

1. "Approved" means approved in writing by the Owner and Engineer.
2. "As shown" (or "as indicated" or "as described") means as shown on the drawings and/or described in the specifications.
3. "Contract documents" means the drawings and all sections of the Specifications (including General, Special and Supplementary Conditions, and Instructions to Bidders) taken together.
4. "Contractor's documents" means all documents submitted by the contractor.
5. "Provide" means furnish and install.
6. "Work" means all labor, material, and equipment described by the contract documents.
7. "Work of other trades" means work included in this contract that is normally described in other Sections of the Specifications under the Construction Specification Institute's sixteen division format. (Such work may be described in this Section of this Specification. If it is, the description given in this Section is intended to supplement descriptions of the work given in other Sections of this Specification).
8. "Remove" means to disconnect dismantle or disconnect and dismantle as necessary. All removals not designated for reuse nor designated to be salvaged for the Owner is property of the Contractor. Dispose of removals outside of Owner property.
9. "Replace" means to remove existing and provide new as indicated in same location.
10. "Coordinate" means to locate to avoid (both existing and new) equipment, services, and obstructions.
11. “Reroute” mean to remove parts of system and provide extension to system to circumvent obstruction.
12. “Relocate” means to remove existing, install existing in different location indicated and make operational.
13. “Reinstall” means to remove existing, install existing in same location and make operational.

1.3 BIDS

A. Provide alternate bids and unit prices as requested on the bid form.

B. Manufacturers' names used herein to specify products represent examples of manufacturers who produce equipment and/or materials that meet, or can be modified to meet, the project requirements. Contractor shall verify that products used will meet dimensional requirements of the project and that they can be installed in a complete and operable manner using connections, foundations, blocking, etc., shown on the drawings. If revisions in piping, conduit work, foundations, anchor bolts, connections, etc., are required, make such revisions at no additional expense.

C. If there are conflicts among applicable Codes, or among the contract documents, bid the work with the assumption that the most expensive alternative will apply. If there are conflicts between the contract documents and the Codes, the Codes shall take precedence. If there are conflicts among the contractor's documents, the contractor's price proposal documents shall take precedence over the submittals. If there are conflicts between the contractor's documents and the Codes or Contract Documents, the Codes and Contract Documents shall take precedence. The contractor specifically agrees that exceptions taken in any of the contractor's documents are null and void, and of no force or effect, without acceptance of the proposed exceptions by the Engineer, in writing. Obtain clarification from the Engineer before purchasing equipment or materials or installing the work.

1.4 PERMITS AND INSPECTIONS

A. Owner will obtain and pay for the general building permit, including mechanical plan reviews. Contractor shall obtain all other necessary permits and pay for inspections required by state or local governing agencies.

B. Contractor shall secure at his own expense all permits and pay for any inspection charges required by any Government body having jurisdiction over this construction. Any other permits shall be paid for by the particular contractor whose work is involved.

1.5 CODES AND STANDARDS:

A. Work and equipment shall be installed in accordance with the following codes and standards:

1. The Ohio Basic Building Code (for facilities within the City's jurisdiction) and Codes and Standards referenced therein.
2. Other Codes and Standards referenced herein.

B. Provide evidence that electrical equipment and materials meet the standards of Underwriters Laboratories, Inc. (UL). The listing Mark or Classification Marking of UL displayed on the equipment will be accepted as evidence of such compliance. Third party certification, by a testing agency approved by the authority having jurisdiction, shall be provided if UL certification is not available.

C. Welding qualifications and procedures shall be based on ASME Boiler and Pressure Vessel Code, Section IX.

D. All natural gas piping shall be installed in accordance with the ANSI/ASME B31.1 Power Piping Code and the Ohio Pressure Piping Systems Code, OAC Chapter 4101:8 and the National Fuel Gas Code, NFPA 54. In addition, all gas piping materials and installation, including inspection and testing, of all gas piping shall conform with the requirements of the Duke Energy Gas Installer's Manual, latest edition.

1. Installing contractor shall meet all requirements of The Duke Energy for the gas piping work included in this contract.

E. Pressure piping shall be installed in accordance with ANSI B31.1 Power Piping Code and the State of Ohio Pressure Piping Systems Code. Pressure piping systems shall include all systems indicated by this Code. Systems shall be inspected by an inspector of the Division of Pressure Piping, Department of Industrial Compliance.

F. All materials and workmanship shall be in accordance with the latest editions and addenda of the codes and standards listed below and all Federal, State and local codes. Should there be any conflict between any codes, standard, and/or specification, the more stringent shall govern.

1. **ABMA** - American Bearing Manufacturer's Association
2. **ADC** - Air Diffusion Council
3. **AFBMA** - Anti-Friction Bearing Manufacturer's Association
4. **AMCA** - Air Movement and Control Association
5. **ANSI** - American National Standards Institute
6. **ARI** - American Refrigeration Institute
7. **ASHRAE** - American Society of Heating, Refrigeration and Air Conditioning Engineers
8. **ASME** - American Society of Mechanical Engineers
9. **ASTM** - American Society for Testing Material
10. **AWS** - American Welding Society
11. **EPA** - Environmental Protection Agency
12. **IRI** - Industrial Risk Insurers
13. **ISA** - Instrument Society of America
14. **MSS** - Manufacturer Standardization Society of the Valve and Fitting Industry
15. **NBIC** - National Board Inspection Code
17. NECA - National Electric Contractors Association
18. NEMA - National Electric Manufacturers Association
19. NETA - National Electric Testing Association
20. NFPA - National Fire Protection Association
21. OBBC - Ohio Basic Building Code
22. OSHA - Occupational Safety and Health Act
23. SMACNA - Sheet Metal and Air Conditioning National Association
24. UL - Underwriters Laboratories
26. State of Ohio
27. Local codes and regulations

1.6 SUBMITTALS

A. Submit shop drawings and catalog literature of equipment and systems being provided as part of this work. Submittals shall show size, weight, arrangement, capacities, performance curves, construction details, connection details, wiring and flow diagrams, finish and color, and other features as applicable, to show compliance with the contract documents and suitability for the job requirements. Specific features, characteristics, sizes, model numbers, options, accessories, and all other information necessary to fully identify the items being provided shall be clearly marked on the submittals. Submittals provided without such marking of applicable features shall be returned unreviewed for correction and resubmitted.

B. Submit one copy in electronic Microsoft "WORD" format. Submit the remaining {7} copies in paper format. Contractor may be required to submit samples of materials if color, construction or texture is not specifically addressed.

C. Do not release any equipment for manufacture or shipment to the job until submittals have been returned with Engineer's stamp indicating "No Exceptions Noted."

D. Stamp, initial, and date submittals before submitting them for Engineer's review. Contractor's stamp shall be taken as indication that the Contractor has reviewed the submittals and certifies that it complies with the contract documents and is suitable for the job requirements. Engineer's review will not be a thorough review for contract compliance, and no change in the contract requirements shall be inferred from the Engineer's notations, lack of notations, or affixing of the "No Exceptions Noted" stamp to a submittals.

E. Engineer will mark-up, stamp, and return a maximum of five (7) copies of shop drawings. Where additional copies are required, Contractor shall provide a reproducible drawing or catalog cut sheets that can be copied.

1.7 RECORD DRAWINGS

A. Keep a set of the contract and coordination drawings at the job site on which a running record of changes in routing of services and location of equipment shall
be kept in a neat and legible manner. Engineer may require evidence that record
drawings are up to date prior to approval of pay requests. Record Drawings shall
not be used for construction purposes.

B. At the completion of the job, the record drawings shall be given to the Owner. If
documents are not provided in a neat and legible manner, Engineer reserves the
right to require Contractors to transfer information to clean document copies.

1.8 COORDINATION DRAWINGS

A. Contractor shall provide, after drawings have been approved by the Engineer, an
electronic AutoCAD file of each of the contract plans drawn to a scale of ¼ inch
equals one foot, showing all work dimensions and locations. Submittals of these
drawings shall be construed to mean that Contractor has investigated all site
conditions affecting the installation of the work (dimensions, locations, routing,
obstructions, penetrations through rated walls/floors, etc.) and that provisions for
same are incorporated into the drawings.

B. Electronic AutoCAD files shall be circulated by this contractor to each of the
trades involved on the project. Each respective contractor shall coordinate his
work with the work of all other trades.

C. All contractors involved shall add their work to an electronic AutoCAD file,
indicating size and location; Overlay drafting techniques or layering upon
AutoCAD files may be used. Sign-off and date shall be included for each
contractor. Copies of all coordination drawings of all contractors shall be
provided to the Engineer for approval before any work is begun.

1.9 MAINTENANCE MANUAL AND OPERATING INSTRUCTIONS

A. Provide maintenance and operating manuals bound in 8½ inch x 11 inch
hardback, three-post binders. Manuals shall contain written instructions for each
system, approved shop drawings, schematic drawings, equipment catalog cuts
and manufacturers' instructions.

B. Arrange information in the following sequence: project title, Owner's name and
address, date of submittals, name of Contractor, name of Engineer, index, shop
drawings, operating and maintenance instructions, Contractor's purchase order
numbers, suppliers' names/phone numbers/addresses, Year 2000 Compliance
certificates, date of startup of each piece of equipment, and date of Owner's
acceptance of each piece of equipment.

C. Submit one copy for review. Make required corrections, and submit six record
copies.

D. All training and start-up procedures shall be video-taped, and 1 copy shall be
provided to the Owner on standard VHS tapes.

1.10 FIELD MEASUREMENTS
A. Utilize benchmarks provided when taking measurements. Take all field measurements necessary to properly provide the work. Do not rely on measurements taken or provided by others or scaled from drawings.

B. Contractor shall take all his own measurements and be responsible for them, and shall also be responsible for and shall verify in the field all dimensions and elevations of existing work and work provided by others.

1.11 PROTECTION OF EQUIPMENT, MATERIALS, UTILITIES, AND FACILITIES

A. Protect existing buildings, grounds, utility lines, and equipment from damage resulting from work performed. Verify locations of underground utilities, or those otherwise obscured from view, in the vicinity of the work before work commences. If any item is damaged, promptly repair or replace it to the satisfaction of Owner.

B. Provide secure housings during construction for job tools, material, and equipment. Protect materials and equipment at all times from weather and other exposure to water and extreme temperatures and humidity. Materials or equipment sustaining damage in any way shall be repaired or replaced as directed by the Engineer.

C. Protect roofs by using plywood planking to cover walkways and work areas on roofs. Make roof penetrations and install curbs and flashing in accordance with roofing manufacturer’s recommendations. Obtain written certification from roofing manufacturer that work has been done properly and that roof warranty has not been voided or altered.

1.12 WORK IN EXISTING BUILDINGS

A. Routing of services must be verified in the field. Anticipate and provide for minor deviations in routing and configuration. No extra costs will be allowed because of such deviations.

B. If asbestos, PCB’s, or other hazardous materials are encountered in the course of the work, stop work in the vicinity of such materials and report their presence to the Owner. Owner will arrange for proper removal and disposal of hazardous materials.

1.13 CLEAN UP

A. Daily dispose of trash and debris caused by this work. Remove trash from the site and keep emergency egress paths clear. Sweep floors and hidden surfaces above false ceilings daily in work areas.

1.14 WARRANTY

A. Keep this work and every part thereof, in perfect condition, usual wear excepted, for a period of one year beginning upon the later of either the date of acceptance of the work by the Owner (after successful operation has been demonstrated to the satisfaction of the Owner and Engineer) or the date of issuance of certificate.
for final payment, unless another date is established and agreed upon between the Owner and Contractor. Remedy, without expense to the Owner, any and all defects, whether in material, workmanship, or operation, that may become apparent during this period. This warranty shall include all labor, materials, and services necessary to permanently correct the deficiencies.

PART 2 - PRODUCTS

2.1 MANUFACTURED PRODUCTS

A. All materials and equipment to be used for this contract shall be standard products of a reputable manufacturer regularly engaged in the production of same. The manufacturer's nameplate indicating model number, serial number and performance data shall be permanently affixed to all equipment furnished under this contract. The equipment shall be the manufacturer's latest model.

B. All materials and equipment provided under this contract shall be new and in perfect condition, and shall be furnished in ample quantities and at the proper time. All materials used in the fabrication or construction of the various parts of the equipment included in this contract shall be made in the United States in accordance with codes, standards or specifications which are applicable.

C. The drawings are based on the use of products specified and listed first. If any revision in piping, conduit work, foundations, anchor bolts, connections, etc., is required by other named products or approved substitutions, it shall be the Contractor's responsibility to make such revisions at no additional expense to the Owner.

D. The inclusion of a manufacturer's name in the specifications does not imply that all of that manufacturer's standard products and options are acceptable. Manufacturers shall modify their standard offerings, if necessary, to comply with the contract documents.

PART 3 - EXECUTION

3.1 EQUIPMENT RECEIVING AND HANDLING

A. For all new equipment for which the Contractor is responsible, he shall receive equipment on site, remove from shipping materials, inspect for damage, verify that all components are provided, convey equipment into position, and install in accordance with the Contract Documents. Report any damage to equipment immediately. Damaged items shall be replaced by the equipment supplier, or the responsible party.

3.2 ACCESS PANELS

A. Supply access panels, which may or may not be shown on the drawings, in walls and plaster or dry wall ceilings for items requiring maintenance or adjustments, such as dampers, valves, or controls. Panels shall be installed by the General Contractor.
B. Items requiring access shall be located above removable ceiling panels where possible.

C. Access panels shall be Inryco-Milco style "K" for plastered ceilings, and style "M" for tile or non-plastered walls. Panels shall have hinged doors with cam locking device and prime coat paint finish.

D. Before installation of panels, secure the Architect's approval of the locations, sizes, and types. Ceiling access panels requiring shoulder entry shall be at least 18 x 24 in.; those requiring hand entry shall be at least 12 x 12 in., and large enough to reach all items.

E. Designate removable ceiling panels required for access to items requiring maintenance. This Contractor shall mark these panels in a manner acceptable to the Owner, Architect, and Engineer.

3.3 CONCRETE WORK, ANCHOR BOLTS, ETC.

A. Provide concrete equipment pads and other concrete work as shown, or as required, for all equipment provided. Equipment pads shall be four (4) inches thick (above finished floor, or above grade), unless indicated otherwise. Finished tops of pads shall be flat and level to within 1/8 IN. tolerance end-to-end and side-to-side, and shall not have "ripples" or other irregularities.

B. Concrete shall be ASTM C150, Type I or II, and shall have a minimum compressive strength of 3,000 PSI 28 days after pouring.

C. Mix shall be very dense so as to be waterproof after setting.

D. Formwork shall be preformed galvanized systems.

E. Reinforcing steel shall be ASTM A615 or ASTM 616, and placement shall conform with requirements of ACI-318.

F. Fasten equipment to pads with anchor bolts and nuts. Provide anchor bolts of size recommended by manufacturer with 3 inch hook and sleeve.

G. Equipment pads to receive grouted-in bases shall have a rough level surface.

H. After installation of equipment, this Contractor shall level equipment with steel shims, tighten anchor bolts and grout between equipment base and concrete pad using Embeco no. 713 nonshrink, high strength grout meeting the requirements of CRD-C588-76, 78A. Minimum grout thickness shall be ¾ inch. Grout shall be mixed and placed in strict accordance with the manufacturer's directions.

3.4 EQUIPMENT LEVELING AND ALIGNMENT

A. All equipment provided by the Mechanical Contractor shall be set true and plumb and drives shall be in proper alignment.
B. Contractor shall provide a millwright to properly align each driver with its respective piece of driven equipment in accordance with manufacturers’ recommendations. Millwright credentials and qualifications shall be submitted to Owner for approval.

C. Bedplates shall be properly shimmed with steel stock prior and then grouted in. Grout shall be non-shrink type and shall fill all void spaces under bedplates, etc.

D. Mechanical Contractor shall be responsible for all grouting required for installation of equipment provided under this contract. Grout shall be Master Builders Co.’s Embeco 713, pre-mixed non-shrink grout or equal. Grout shall be prepared and placed in accordance with manufacturer’s recommendations. After grout has set, base plates shall be tightened in place and alignment rechecked.

E. After assembly has been finally aligned and shimmed, drill and ream feet and base plate and install taper pins with nut on top for pullout removal. One front foot and diagonally opposite rear foot of motors and turbines shall be pinned to base plate.

F. No equipment installed by this Contractor shall be placed in service or operated without approval of manufacturer.

G. All major equipment start-up shall be by a factory representative directly employed by the manufacturer. Credentials and qualifications of representative shall be submitted to the Owner for approval.

3.5 CUTTING AND PATCHING

A. Do all cutting and core drilling required for heating, ventilating and air conditioning work. Core drill holes and grout in sleeves for piping. Openings shall be no larger than required to install the services.

B. Cutting shall be kept to a minimum. Obtain approval of Architect before cutting or drilling.

C. Replace and repair any ductwork, conduit, piping, etc., that is damaged during cutting or drilling.

D. Cooperate with the other contractors to insure that openings of the proper size and location are provided for all work.

E. Patching around openings cut by this contractor or provided by others for him shall be done in a neat and workmanlike manner. Patching shall be done by an approved qualified contractor, but shall be paid for by this contractor. Finished patching shall retain fire and smoke ratings of cut partitions and shall match surrounding finish.

3.6 PAINTING

A. Touch up equipment having factory finishes wherever finish is damaged, and provide other specified painting.
B. All carbon steel uninsulated piping shall be painted including natural gas and compressed air piping

3.7 HANDLING, STORAGE AND PROTECTION OF EQUIPMENT

A. Any damage to the building structure, walls, etc., from this Contractor's, or any of his subcontractor's failure to take proper precautions in handling equipment, storing equipment, etc., shall be repaired at no cost to the Owner.

B. Equipment stored at the site shall be protected from the elements and kept in clean condition. Any piping, equipment, etc., that is rusted or damaged in any manner shall be removed and replaced as directed.

3.8 INSTALLATION

A. Equipment and components shall be completely installed in accordance with manufacturer's recommendations and in a manner to insure proper and sequential operation of the equipment and its controls. Installation of equipment not covered herein or in manufacturer's instructions shall be installed as directed by manufacturer's representative. Proper foundations for mounting of equipment, accessories, appurtenances, piping and controls shall be provided, including but not limited to supports, vibration isolators, stands, guides, anchors, clamps and brackets. Foundations for equipment shall conform to equipment manufacturer's recommendation. All equipment shall be bolted to foundations. Provide anchor bolts and sleeves as recommended by the manufacturer and set accurately using properly constructed templates.

B. Equipment shall be located so that working space is available for all necessary servicing.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. This specification covers mechanical demolition of existing systems.
B. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

1.2 ASBESTOS AND HAZARDOUS MATERIALS

A. If asbestos, PCB’s, or other hazardous materials are encountered in the course of the work, stop work in the vicinity of such materials and report their presence to the Owner. Owner will arrange for proper removal and disposal of hazardous materials.
B. Contractor shall make his employees and subcontractors aware of this situation, and shall take appropriate precautions to prevent exposure to the materials.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Extent of demolition is as indicated upon the drawings, or as required to accomplish the work. The Contractor shall visit the site prior to submitting his proposal and familiarize himself with the complete extent of the demolition and removal work.
B. Verify field measurements shown on Drawings.
C. Verify that equipment to be demolished serves only the areas indicated, and not areas which will remain in service.
D. Demolition work is based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.
E. Beginning of demolition means installer accepts existing conditions.
3.2 PREPARATION

A. Coordinate work with Owner, Construction Manager, and other contractors on-site. It is the Mechanical Contractor’s responsibility to determine through coordination with the Construction Manager which mechanical systems components will remain in use.

B. Building Occupancy: Owner will be continuously occupying the building. Conduct demolition in a manner to minimize disruption of Owner’s operations. Provide minimum 72 hours advance notice to Owner of demolition activities which will impact Owner’s normal operations.

C. Contractor shall schedule all demolition work in an orderly and systematic manner so as to minimize disruption of the hospital functions. Schedule shall be submitted for Owner’s approval before any work is begun.

D. Protections: Contractor shall coordinate with all trades for all work specified in this project and shall provide the necessary barricades and dust control to protect Owner’s personnel, the general public, or hospital patients from injury, provide them safe passage to and from occupied portions of the building, and protect floors, walls, ceilings, furnishings, and equipment from damage or exposure to dust or debris.

E. Where so indicated, the remainder of the mechanical systems and components not being demolished (but on the same systems as items being demolished) shall remain in service during the work. Take all necessary measures to keep these remaining items fully functional (e.g., blankoff demolished ducts, cap demolished pipes, etc.). If any of the remaining systems or components must be temporarily taken out of service, coordinate the outage with the Owner.

F. When work must be performed on energized equipment, coordinate work with electrical contractor and construction manager. On-site Electrical contractor shall perform all electrical work.

3.3 DEMOLITION OF EXISTING MECHANICAL WORK

A. Remove all equipment shown on the mechanical demolition drawings. Equipment shall become the property of the contractor and shall be removed from the property as expeditiously as possible, except as described below.

B. Certain equipment shall be removed and turned over to Owner, if so described on the drawings, or directed by Owner. As a general rule, this includes all copper materials. Coordinate the disposition of all equipment with Owner.

C. Maintain access to existing installations.

3.4 CLEANING, REPAIR, PATCHING

A. Remove debris, rubbish, and other materials resulting from demolition from the site on a daily basis. Clean area after all work is complete. Transport and legally dispose of materials off site.
B. Wherever structures will be re-used, repair walls, floors, and roof where removal of equipment has caused damage or left openings. Cap all roof openings. Work shall be done in accordance with architectural specifications. Walls, floor, and roof repairs shall maintain fire and/or smoke ratings of the building element, using like materials and construction methods.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. This specification covers the provision of supports and hangers for all piping.

B. All pipe hangers, supports and pipe hanger accessories shall be suitable for the load and pipe movements at the specific point where they are installed. In addition, the attachment of pipe hangers to building steel members shall not impose torsional forces on these members.

C. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipe hangers, guides, springs, and supports shall conform to ANSI B31.1 and Fed. Spec. WW-H171, and shall be manufactured by Anvil International, Cooper B-Line Systems Inc., Piping Technology & Products, Inc. or approved equal. Anvil figure numbers are given for example unless otherwise indicated. Products by other manufacturers shall equal or exceed those shown.

B. Provide pipe hangers and supports of the figure numbers listed in this section or as shown on the drawings. Provide custom fabricated welded steel piping supports or support brackets as shown on the drawings and as required for all locations which require additional support or bracing of piping.

C. All pipe hangers, supports, and accessories exposed to the outdoors shall be galvanized with zinc coating to G60 minimum thickness.

2.2 INSERTS AND ANCHORS

A. This section applies when piping is supported from ceiling slabs, concrete walls, columns and other building masonry (except floors).

B. Where support rod size exceeds \( \frac{3}{8} \) in. diameter or where the load exceeds the recommended load for the insert or anchor, use two inserts or anchors with a trapeze-type connecting member below the concrete.

C. Where installation can be made before the concrete is poured, use figure nos. 282 or 281 inserts.

D. Where installation is made after the concrete is in place, use Phillips “Red Head” expansion anchors, Rawl-Studs, Rawl self-drilling anchors, or Hilti Kwik-Bolts.
E. Plastic, lead or fiber screw anchors, lag screws and expansion shields are not acceptable for this application.

F. Floor anchors shall be cast-in-place anchors of heavy structural steel or cast iron where possible.

2.3 BEAM ATTACHMENTS

A. This section applies where piping is supported from overhead building steel.

B. Provide necessary structural steel members spanning between beams to create hanger attachment points.

C. Beam attachments for all pipe 3 in. and larger shall be welded figure no. 66.

D. Beam attachments for pipe 2 in. and smaller shall be non-welding figure nos. 225, 133 or 134 where suitable for the load. Contractor may at his option provide welded attachments.

E. Repair fireproofing on structural beams where removed for pipe support. Repair shall be done by a qualified tradesman.

2.4 WALL ATTACHMENTS

A. For wall supports on either concrete or steel, figure nos. 194, 195 and 199 welded steel knee brace type brackets may be used where suitable for the load.

B. Use figure nos. 195 and 199 in conjunction with a backplate of such thickness and size to properly distribute the weight over the wall.

C. Provide custom fabricated knee brace brackets as required for support locations which exceed the load bearing or wall weight distribution capabilities of the bracket figure numbers listed.

2.5 HANGER RODS

A. Hanger rods shall be hot rolled steel with cut coarse threads. All eye rods used for hangers shall have welded eyes.

B. Where rod sizes are listed in the catalog for a type of fitting, that size shall govern.

C. Where rod sizes are not listed, the rod size shall conform to the following table (based on spacing shown in Section 3.1):

<table>
<thead>
<tr>
<th>Pipe Size (In.)</th>
<th>Rod Size (In.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 and smaller</td>
<td>⅜</td>
</tr>
<tr>
<td>2½ - 3</td>
<td>⅜</td>
</tr>
<tr>
<td>4 and 5</td>
<td>⅜</td>
</tr>
<tr>
<td>6</td>
<td>⅜</td>
</tr>
<tr>
<td>8 thru 12</td>
<td>⅞</td>
</tr>
</tbody>
</table>

Fosdick & Hilmer, Inc. © 2012  23 05 29 - 2    PIPE HANGERS AND SUPPORTS
2.6 HANGERS AND SUPPORTS

A. General

1. Hangers and supports for tubing shall be specified for tubing in order to be of the proper diameter.

2. Hangers and supports that are in direct contact with copper shall be copper-plated or plastic-coated to prevent any electrolytic reaction.

B. Provide supports and hangers as follows:

1. Compressed air, instrument air, natural gas, and miscellaneous equipment drains and vent systems (ambient to 120 degrees F):
   a. Hangers: fig. no. 260 adjustable clevis hanger
   b. Supports: fig. nos. 258, 259 and 264 pipe stanchion saddle supports.

2. Hot water supply and return, hot drains and vents (hot to 400 degrees F):
   a. Insulated - Insignificant Thermal Movement:
      i. Applies where thermal movement will not cause the hanger rod to deviate more than 5 deg. from the vertical, or where longitudinal expansion will not cause a movement of more than ½ in. in the piping supported from below.
      ii. Hangers: figure no. 260 and 300
      iii. Supports: figure nos. 258, 259 and 264.
   b. Insulated - Thermal Movement:
      i. Hangers: figure no. 181 adjustable steel yoke pipe roll, figure no. 177 adjustable pipe roll support.
      ii. Supports: figure no. 271 pipe roll stand, figure no. 274 adjustable pipe roll stand.
      iii. Saddles (piping): fig. nos. 160 thru 164 (weld to pipe)
3. Special Materials

   a. Trapeze Hangers: Steel angle or channel construction with suspended adjustable steel thread rods and nuts.

   b. Spring Supports: For support of piping where vertical movement occurs, use figure B268 variable spring hanger.

4. Supports and hangers on insulated lines shall accommodate insulation thicknesses specified under Section 23 07 10 "INSULATION OF MECHANICAL SYSTEMS" of this specification.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Contractor shall provide all structural supports, anchors and hangers required for installation of piping in accordance with the Ohio Power Piping Code and ANSI/ASME B31.1. Pipe hangers and supports shall be installed to allow for expansion and contraction, and placed close to fittings, valves, and heavy equipment. They shall be installed so that piping will be free from vibration, sagging or movement other than that caused by heat expansion or contraction. Piping shall be pitched as specified in individual service specification or as indicated.

   B. Piping shall be supported directly from the building structure. Pipe may be supported by trapeze hangers and/or in tiers, but there shall be sufficient room for installation of fittings, insulation, etc., and for future rearrangement work or maintenance.

   C. Unless shown otherwise on the drawings, there shall be no cutting or drilling on existing building steel.

   D. Maximum spans between hangers for straight horizontal runs of steel and copper pipe shall be in compliance with the following table:

<table>
<thead>
<tr>
<th>Nominal Pipe Size (In.)</th>
<th>Maximum Span (Ft.)</th>
<th>Nominal Pipe Size (In.)</th>
<th>Maximum Span (Ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>½</td>
<td>5</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>¾</td>
<td>6</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>1½</td>
<td>9</td>
<td>12</td>
<td>23</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>2½</td>
<td>11</td>
<td>16</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>3½</td>
<td>13</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>24</td>
<td>32</td>
</tr>
</tbody>
</table>
E. Additional hangers shall be provided where concentrated weights such as valves or heavy fittings occur, and where changes in direction of the piping system occur between hangers.

F. Hanger rods shall be connected to beam clamps, beam attachments, concrete inserts or expansion anchors. “C” clamps shall not be allowed. Offset suspension by hangers is not permitted. Hanger rods shall be installed with a double nut arrangement both at the lower end where the hanger is attached, and the top where it fastens to the clamp or insert. Inserts shall be provided as specified elsewhere in this specification. When through-bolts are used, plates or large washers shall be provided under the heads.

G. All piping shall be properly braced to prevent vibration and also to prevent lateral movement where necessary by means of heavy steel braces with turnbuckles.

H. If, after Contractor completes his work, the Engineer or the Owner requires that the Contractor provide additional hangers, supports or brackets to more adequately support or brace the piping system, this shall be done without added cost to the Owner.

END OF SECTION
SECTIO\n
SECTION 23 05 30

PIPE SLEEVES AND PLATES

PART 1 - GENERAL

1.1 SCOPE

A. Provide pipe sleeves for all pipes that penetrate floors, ceilings, walls or steel grating platforms.

B. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall conform to the respective specifications and other requirements specified.

2.2 SLEEVES

A. Sleeves in walls, floors and grating shall be standard weight galvanized steel. Weld a steel bar to floor sleeves in poured concrete. Use copper sleeves for uninsulated copper pipe utilizing a brass rod in lieu of the steel bar.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES

A. Sleeve location and size shall be determined in advance and installed during the initial stages of construction. Coordinate sleeve locations to avoid interference with other trades. Do not sleeve beams, joists or other structural members.

B. Floor sleeves in unfinished areas shall extend 4 inches above floor. All sleeves shall be sealed to be watertight.

C. Sleeves shall be sized to provide a minimum clearance of ¼ in. on all sides from pipe insulation and ½ in. on uninsulated pipe. Pipe insulation shall be continuous through sleeves.

D. After pipes are installed in sleeves, they shall be held centered in sleeves until insulation is installed.

E. Where located in fire walls pack annular space between pipe or pipe insulation and sleeves for a minimum depth of 1 in. at each wall and floor surface with fiberglass and seal with elastic cement. This shall apply to exposed and concealed work.

F. Unused sleeves shall be plugged and finished to match adjacent surface. Use non-shrinking grout where required to patch for floor sleeves.
G. Pipes passing through exterior walls shall be equipped with flashing and counterflushing or otherwise sealed to be weathertight.

H. Cut steel bar grating as required to install pipe sleeves. Weld sleeve in place. Provide supplemental steel to reinforce grating span for all sleeves 3 inch and larger.

END OF SECTION
SECTION 23 05 53

IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE

A. Contractor shall provide and install pipe markers, valve tags and equipment labels for all new work.

B. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

PART 2 - PRODUCTS

2.1 PIPE MARKING

A. Provide Seton colored band, block and pressure sensitive pipe markers to designate piping systems. Arrows shall indicate the direction of flow. Upper case letters and Arabic numbers shall be used.

2.2 TAGS

A. Shall be brass at least 1½ inches in diameter with depressed black characters ½ inch high.

B. Exact identification of the material contained in piping shall be according to the following tables.

TABLE 1 - ANSI BAND AND LETTER SIZE

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe Covering</th>
<th>Width of Color Band</th>
<th>Size of Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾&quot; to 1¼&quot;</td>
<td>8&quot;</td>
<td>½&quot;</td>
</tr>
<tr>
<td>¾&quot; to 1¼&quot;</td>
<td>8&quot;</td>
<td>¾&quot;</td>
</tr>
<tr>
<td>3½&quot; to 6&quot;</td>
<td>12&quot;</td>
<td>1¼&quot;</td>
</tr>
<tr>
<td>8&quot; to 10&quot;</td>
<td>24&quot;</td>
<td>2½&quot;</td>
</tr>
<tr>
<td>Over 10&quot;</td>
<td>32&quot;</td>
<td>3½&quot;</td>
</tr>
</tbody>
</table>

TABLE 2 - ANSI MATERIAL IDENTIFICATION (Note 1)

<table>
<thead>
<tr>
<th>FLUID</th>
<th>LEGEND</th>
<th>COLOR LETTERS</th>
<th>BACKGROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument Air</td>
<td>Instrument Air</td>
<td>White</td>
<td>Blue</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Natural Gas</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>Hot Water Supply &amp; Return</td>
<td>Hot Water Supply &amp; Return</td>
<td>White</td>
<td>Green</td>
</tr>
</tbody>
</table>

(Note 1) Colors shall be as recommended in ANSI Z53.1, latest revision, Safety Color Code for Marking Physical Hazards.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Apply markers to straight pipe runs at not over 15 feet spacing, adjacent to valves, at change-in directions, and where pipe pass through walls or floors. Markers shall be clearly visible from floor.

B. Where pipes are too small or not readily accessible for such application, a brass tag shall be securely fastened in 15 foot intervals.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. General: Provide Testing, Adjusting and Balancing in accordance with requirements of the Contract Documents.

1.2 SECTION INCLUDES

A. Testing, adjusting and balancing of water systems.

1.3 RELATED WORK

A. Division 23 - Mechanical.

1.4 REFERENCES

A. AABC - National Standards for Total System Balance
B. ADC - Test Code for Grilles, Registers and Diffusers
C. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems
E. SMACNA - HVAC Systems Testing, Adjusting and Balancing

1.5 SUBMITTALS

A. Submit name of testing, adjusting, and balancing agency for approval within 7 days after award of Contract.
B. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting and balancing of systems and equipment to achieve specific performance.
C. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
D. Submit draft copies of report for review prior to final acceptance of project. Provide final copies for Engineer and owner for inclusion in operating and maintenance manuals.
E. Provide reports in soft cover, letter size binders complete with index page and indexing tabs, with cover identification at front side.
F. Include detailed procedure, agenda, sample report forms and a copy of Performance Guarantee.

G. Test Reports: Indicate data on AABC or NEBB forms containing information indicated in schedules.

1.6 QUALIFICATIONS

A. Agency: Independent company specializing in testing, adjusting, and balancing of systems specified in this Section with minimum five years documented experience. Company shall have no affiliation with the business(es) of other Contractors performing work upon this project.

B. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

C. Work shall be performed by an AABC Certified Test and Balance Engineer, NEBB Certified Testing/Balancing Supervisor, or registered Professional Engineer experienced in performance of this work and licensed in the State of Ohio. The individuals actually performing the work shall be certified by AABC or NEBB; reliance upon the company’s (not individual’s) certification shall not be acceptable.

1.7 QUALITY ASSURANCE

A. Contractor’s Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

PART 2 - PRODUCTS

2.1 (NOT USED)

PART 3 - GENERAL PROCEDURE

3.1 EXAMINATION

A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 MANDATORY PRE-BALANCE SUBMITTALS

A. One week prior to commencing work of this section, present schedule of work.
Review all sequences of operation with Engineer and delineate methods to be used in performance of the work that will verify that all system parameters are appropriately tested and adjusted for all operating sequences. Verify that all prior coordination with all other contractors has been accomplished, and that appropriate parties shall be scheduled to perform related work during the testing and balancing as necessary.

3.3 SEQUENCING

A. Sequence work to commence after completion of systems. Schedule completion work in cooperation with other trades before substantial completion of project.

3.4 GENERAL PROCEDURE

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating 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. Hydronic systems are flushed, filled and vented.
5. Proper strainer baskets are clean and in place.
6. Air outlets and inlets are installed and connected.
7. Service and balancing valves are open.

B. Submit field reports. Report defects during performance of services which prevent system balance.

C. Beginning of work shall signify acceptance of existing conditions.

D. Provide instruments required for testing, adjusting and balancing operations. Make instruments available to the Engineer to facilitate spot checks during testing.

E. Hydronic Systems: Adjust to within plus 5 or minus 5 percent of design.

3.5 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of dampers and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
D. Leave systems in proper working order, replace belt guards, closing access doors, closing doors and restoring thermostats to specified settings.

E. At final inspection, re-check random selections of data recorded in report. Re-check points or areas as selected and witnessed by Owners.

3.6 HYDRONIC SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference and energy balance calculations across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements. Verify that balance is maintained when three-way valves are open to bypass.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

3.7 SPECIFIC REQUIREMENTS

A. The following systems and related equipment shall be tested, adjusted and balanced.

1. Hot Water Heating Primary

3.8 REPORT FORMS: Provide for all listed components that are included in the work.

A. Title Page

1. Name of Testing, Adjusting, and Balancing Agency

2. Address of Testing, Adjusting, and Balancing Agency

3. Telephone number of Testing, Adjusting, and Balancing Agency

4. Project name

5. Project location

6. Project Engineer
7. Project Contractor
8. Report date

B. Summary Comments
1. Design versus final performance
2. Notable characteristics of system
3. Description of systems operation sequence
4. Nomenclature used throughout report
5. Test conditions

C. Instrument List
1. Instrument
2. Manufacturer
3. Model number
4. Serial number
5. Range
6. Calibration date
7. Calibration method and Traceability

D. Electric Motors
1. Manufacturer
2. Model/Frame
3. HP/BHP
4. Phase, voltage, amperage; nameplate, actual, no load
5. RPM
6. Service factor
7. Starter size, rating, heater elements
8. Sheave Make/Size/Bore
9. Efficiency
E. V-Belt Drive:
1. Identification/location
2. Required driven RPM
3. Driven sheave, diameter and RPM
4. Belt, size and quantity
5. Motor sheave diameter and RPM
6. Center to center distance, maximum, minimum, and actual

F. Pump Data:
1. Identification/number
2. Manufacturer
3. Size/model
4. Impeller Size, Design and Actual (final, if trimmed)
5. Service
6. Design flow rate, pressure drop, BHP
7. Discharge pressure
8. Suction pressure
9. Total operating head pressure
10. Shut off, discharge and suction pressures
11. Shut off, total head pressure
12. Setpoints for remote Delta-P controllers for VFD controlled systems

G. Heating Coil Data:
1. Identification/number and characteristics (rows, fins/inch, circuiting, and verify supply/return piping connections are correct)
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Water flow, design and actual
7. Entering water temperature, design and actual
8. Leaving water temperature, design and actual
9. Entering air temperature, design and actual
10. Leaving air temperature, design and actual
11. Air pressure drop, design and actual
12. Water pressure drop, design and actual

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. This section includes providing insulation and covering for equipment and piping.

B. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

C. Refer to Section 23 21 13 “PIPING MATERIALS AND METHODS”

1.2 SURFACE BURNING CHARACTERISTICS

A. Insulation materials, adhesives, coatings and other accessories shall have surface burning characteristics as determined by ASTM E 84 not to exceed 25 for flame spread and 50 for smoke developed. Glass fiber insulation shall be non-combustible and U.L. rated.

B. Every package or standard container of covering, adhesive and coating delivered to the building for use must have the manufacturer's stamp or label attached, giving name of manufacturer and brand.

PART 2 - PRODUCTS

2.1 GENERAL

A. Covering materials shall be as manufactured by Manville, Owens-Corning, Armstrong, Knauf Fiber Glass, or approved equal.

B. Adhesives shall be flame retardant type equal to Benjamin-Foster suitable for operating and service conditions for which they are used.

2.2 INSULATION MATERIALS

A. Equipment

1. Glass fiber insulation density shall be 3 lb per cu ft or more and conform to ASTM C411 and C612 test methods. Material shall be suitable for use up to 850 deg. F. and shall be Owens Corning Fiberglas Insul-Quick or approved equal.

2. Laminated kraft-aluminum foil jacket fiberglass insulation shall be semi-rigid and conform to ASTM C411 and C1136 test methods.

3. The following are specific material and thickness requirements:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Material</th>
<th>Thickness (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Water Primary Pumps</td>
<td>Fiberglass</td>
<td>1</td>
</tr>
</tbody>
</table>

Fosdick & Hilmer, Inc. © 2012    23 07 10 - 1 INSULATION OF MECHANICAL SYSTEMS
B. Piping

1. Glass fiber pipe insulation shall be preformed, sectional, 4 lb per cu ft density type conforming to ASTM C547.

2. Valves 6 in. and larger in hot piping shall be insulated with removable, flexible insulating jackets. Flexible jackets shall be Insulation Technology, Inc., Insulation Fabricators, Inc., Performance Contracting, Inc., or equal. Jackets shall have a fiberglass core with PTFE coated fiberglass inner and outer jacket. Insulation thickness shall match adjacent pipe insulation. Seam construction shall be PTFE or Kevlar thread. Closures shall be Velcro hook and loop closure strips or 304 stainless steel lacing and hooks.

3. The following are specific material and thickness requirements:

<table>
<thead>
<tr>
<th>System</th>
<th>Size (in.)</th>
<th>Material</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWS, HWR</td>
<td>½ - 1 ¼</td>
<td>Fiberglass</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1 ½ - 10</td>
<td>Fiberglass</td>
<td>2</td>
</tr>
</tbody>
</table>

2.3 METAL JACKETING

A. Metal jacketing shall be 0.016 in. thick ASTM B209 embossed aluminum jacketing with factory attached vapor barrier as manufactured by Childers or approved equal.

B. Vapor barrier shall be Kraft paper coated with 1 mil thick polyethylene film.

C. All equipment, piping and ductwork insulation shall be covered with a metal jacket unless specified otherwise.

PART 3 - EXECUTION

3.1 INSULATION OF PIPING

A. All surfaces must be clean and dry and pipe lines tested before applying pipe insulation. If insulation is applied prior to testing, and defects appear at or before the time of inspection and tests, the insulation shall be removed, and after defects have been corrected, shall be reinstalled at Contractor's expense.

B. Insulation shall be dry when installed and during the application of any finish. Surfaces of covering shall be smooth, even and substantially flush to adjacent pipe covering.

C. Follow manufacturer's application instructions for all materials. All joints shall be tight with insulation lengths and segments tightly butted against each other. Where lengths or segments are cut, cuts must be smooth and square, and without breakage of end surfaces. All insulation shall be continuous through wall and ceiling openings and sleeves.
D. Where vapor barrier jackets are used on cold surfaces, insulation must be applied with vapor seal integrity maintained throughout the entire system.

E. Do not apply insulation over steam traps, pipe plugs, blind nipples, nameplates, inspection stamps or identification tags.

F. Hot lines such as safety valve vents, or any miscellaneous piping which may at any time have a surface temperature above 140 deg. F., shall be insulated for personnel protection even though the specifications may not otherwise require insulation of the piping. Such insulation shall be of the thickness specified above and shall extend up to a minimum of 7 ft. 0 in. above the nearest floor or platform.

G. Exercise extreme caution in the storage and application of flammable adhesives.

3.2 INSULATION OF FITTINGS, VALVES, FLANGES AND STRAINERS

A. Fittings and valves 3 in. and smaller on calcium silicate insulated lines shall be covered with an ASTM C195 combination insulating and finishing cement. Cement shall be applied to a smooth finish flush with the adjoining sectional pipe covering.

B. Fittings and valves 3 in. and smaller on fiberglass insulated lines shall be covered with glass fiber blanket with vapor barrier to a thickness equal to adjoining pipe insulation. Wrap with vapor sealing tape and apply ¼ in. layer of combination insulating and finishing cement and insulation.

C. All fittings 4 in. and larger shall be insulated with commercially available molded fitting covers or with nested and/or mitered sectional pipe covering of the same material and thickness as the adjacent pipe insulation. Insulation shall then receive one coat of finishing cement with glass fiber reinforcing cloth applied to form a smooth finish in accordance with manufacturer's recommendations.

D. Valves 6 in. and smaller shall have bodies up to the bonnets insulated with nesting pipe insulation of appropriate size and of the same material and thickness as the adjacent pipe insulation. Packing nuts of valves shall not be insulated.

E. Flanges shall be insulated with nesting pipe insulation. The flange insulation shall extend not less than 2 in. over the adjacent pipe insulation on each side of the flange. Insulation on pipes shall be stopped short of flanges to permit removal of flange bolts. The flange insulation shall be applied in such a manner that it may be removed without damage to the adjacent pipe insulation.

F. Wherever nested or sectional covering is used, it shall be cut to fit in a neat and workmanlike manner with all joints butted and held securely in place.

G. Unions and traps shall not be insulated.
3.3 INSTALLATION OF GLASS FIBER INSULATION

A. Install board insulation using bands or by impaling on pins and fastening with speed washers. Use ½ in. or ¾ in. bands on 12 in. to 18 in. centers, or use six pins per 2 ft. by 4 ft. piece.

B. Wherever stiffener bars or stiffener angles extend beyond plane surface being insulated, provide 1 in. minimum thickness of insulation over stiffeners.

3.4 JACKETING

A. Aluminum jacketing shall be applied with 2 in. horizontal and vertical laps. Jacket shall be secured with pop rivets with stainless steel stem and mandrel on 4 in. centers or with ¾ in. stainless steel bands on 18 in. centers.

B. Seal all points where the jacket terminates or where access doors protrude through the jacket.

C. Remove all burrs and sharp edges from metal jacketing immediately around access door handles or other manually operated devices to avoid injury to operating personnel.

D. Aluminum jacketing covering pipe insulation shall have axial seams overlapped a minimum of 2 in. Longitudinal seam overlap shall be secured with stainless steel screws on 6 in. centers maximum. Jacket shall be installed so as to provide a weathertight cover. Fittings, flanges and valves shall be covered with preformed aluminum covers. Premolded PVC fitting covers are also acceptable.

END OF SECTION
SECTION 23 09 93

SEQUENCE OF OPERATION AND CONTROLS REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This specification includes operating sequences for the following new equipment installed under this project:

1. Hot Water boilers

B. This section includes general requirements for the BAS (Building Automation System)

C. The automatic temperature controls system (ATC) shall provide master scheduling for all equipment so noted herein. This timeclock function shall provide the ability to schedule events 24 hours per day, 7 days per week, 365 days per year (and 366 for leap years) based upon a real-time clock, and shall provide timestamp ability for all events (logs, alarms, etc.). All timeclock functions of the ATC shall be real-calendar and real-time based, and software functions shall in no way be affected by the year 2000 or subsequent leap years.

D. Wherever in the following sequences of operation the phrases “interfaced by the Building Automation System” or similar phrases are used, this shall mean that the information shall be stored in memory of the main ATC controller(s), and transmitted to the central host personal computer, and that appropriate alarm messages may be automatically transmitted and printed.

1.2 HOT WATER BOILERS

A. All operating controls and functions of the packaged boilers shall be accomplished by the controls supplied by the manufacturer. The factory supplied controls shall regulate the on-off operation, staging, and lead-lag sequencing.

B. The boilers have been prepurchased and a submittal is available.

C. The boiler control system consists of individual boiler control panels (three total) and a programmable lead-lag control system provided by the manufacturer. Each boiler control panel will be equipped with the necessary isolated auxiliary contacts, accessory I/O modules and programming to facilitate remote enable command from a Building Automation System. Remote enable command shall direct the boiler control system perform its designated tasks associated with each boiler. In addition, the following points for each unit will be interfaced by the Building Automation System:

1. Enable/disable command from each boiler control panel

2. Remote hot water temperature reset.
D. The boiler lead/lag control system consists of a programmable lead-lag control system provided by the manufacturer. The control panel will be equipped with the necessary isolated auxiliary contacts, accessory I/O modules and programming to facilitate remote enable command from a Building Automation System. Remote enable command shall direct the control system to perform its designated tasks associated with the sequencing of each boiler. BACnet driver shall be provided by control contractor.

E. The operation of the new boilers shall be integrated with the existing boilers. The new boilers shall become the lead boilers, and all three new boilers shall be sequenced on prior to enabling existing Unilux boiler. The supply hot water temp shall be incrementally increased up to 180 degrees, and the Unilux shall be enabled after the supply temp has been increased to 180 degrees and the new boilers are not meeting the load. Return water shall be a minimum of 160 degrees in order to allow operation of the boiler.

F. The condensing boilers shall be sequenced as follows:

1. The outdoor air sensor shall reset the supply hot water temp down as low as possible to take advantage of the condensing feature. The minimum supply water temperature shall be 120 degrees. If any of the secondary pumps reach 90% speed, the boiler supply water shall be increased to meet the load, in 10 degree increments.
2. This operation shall be checked and verified. If this reset schedule does not meet the heating requirements of the building, then the supply water temperature shall be incrementally increased until the operation is improved.

1.3 CONTROL DEVICE WIRING REQUIREMENTS

A. The temperature control contractor shall furnish all wiring to make a complete control system. Devices furnished by others to be wired by the control contractor include the following:

1. Combustion air dampers: Boilers will utilize existing combustion air dampers. The top section shall open upon first boiler enable. When proof of open status is achieved, boiler may start. The bottom section shall open upon second boiler enable. When proof of open status is achieved, second boiler may start. Third boiler may start without further action. Control contractor is responsible for all wiring and devices to furnish this action.
2. Control contractor shall wire sensors shipped loose with the boilers.
3. Control contractor shall wire pump start.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION
PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SCOPE

A. Provide all piping, valves, and specialties for the following services as specified and required for complete systems:

1. Natural gas (aboveground)
2. Hot water supply and return
3. Drains and vents

B. Furnish Owner a certificate of inspection and approval from the State Fire Marshal’s Office, Division of Fire Prevention, Boiler Section. This must be submitted before final payment of contract will be allowed.

C. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall be in accordance with the appropriate specification sheets at the end of this section.

B. Provide chain operators on all valves 1½ and larger with valve centerline located 6½ ft. and higher above the nearest floor or platform.

PART 3 - EXECUTION

3.1 FABRICATION AND ASSEMBLY OF PIPING COMPONENTS

A. Piping:

1. All piping shall follow the general arrangement shown, cut accurately to measurements established for the work by the contractor and worked into place without springing or forcing, except where cold-springing is indicated.

2. Welding, brazing and soldering shall conform to ANSI B31.1 and as specified herein. Horizontal runs of piping shall pitch at not less than 1 in. in 20 ft. Provide drain valves at low points of piping system and air vent valves at high points where air pockets would occur.

3. All piping and equipment within building shall be entirely out of the way of electrical conduit, lighting fixtures, equipment and doors, windows and other openings. Provide adequate clearance from walls, ceilings and
floors to permit the welding of joints; at least 6 in. for pipe sizes 4 in. and less, 10 in. for pipe sizes over 4 in., and in corners provide sufficient clearance to permit the welder to work between the pipe and one wall. Provision for expansion and contraction of pipe lines shall be made. All pipe to be insulated shall be run as shown and as required with sufficient clearance to permit application of insulation.

4. Piping shall not be concealed or insulated until it has been inspected, tested and approved. Protect materials and equipment from the weather. Where pipe passes through building structure, pipe joints shall not be concealed but shall be located where they may be readily inspected.

5. Long radius ells shall be used wherever possible to reduce pressure drops. Do not miter pipe to form elbows or notch straight runs to form full sized tees or any similar construction.

6. Except where specifically shown otherwise, run vertical piping plumb and straight and parallel to walls. Trapping of lines shall not be permitted except as otherwise indicated. Provide sleeves of suitable size for all lines passing through building structure.

7. Piping connected to equipment shall be installed to provide flexibility for thermal stresses and for vibration and shall be adequately supported and anchored so that strain from weight and thermal movement of piping is not imposed on the equipment.

8. Each section of pipe, fittings and valves shall be thoroughly cleaned and positively free of all foreign matter before erection. Prior to erection, each piece of pipe shall be held in an inclined position and thoroughly tapped to loosen sand, mill scale and foreign matter. Before all final connections are made to equipment wash the interior of all piping thoroughly with water. Blow out piping with compressed air to remove rust chips, oil and debris. Plug or cap open ends of mains during all shut-down periods. Lines shall not be left open at any place where foreign matter might accidentally enter pipe.

B. Flanged Joints: Faced true, square, tight and used where necessary for normal maintenance and where required to match valves and equipment. Mate with valves and the various equipment connections. Select gaskets, packing and thread compounds for suitability with the particular fluid with which they shall be in contact.

C. Reducing Fittings: Shall be used to connect changes of sizes in piping lines. Use eccentric reducers, flat side down, on steam piping, and concentric reducers on all other piping. Branch connections shall be made with tees except that factory made forged steel welding branch outlets or nozzles having integral reinforcements and conforming to ANSI B31.1 may be used if the nominal diameter of the piping system branch is at least two pipe sizes smaller than the piping segment which contains the fitting.
D. **Dielectric Unions or Flanges:** Provide between ferrous and non-ferrous piping, equipment and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous to non-ferrous connections.

E. **Strainers:** Install strainers with screen drum and in the direction of flow, as marked on the strainer body. Provide clearance for removal and replacing of strainer screens. The strainers shall have screens of ample net free area and shall be composed of materials which shall be compatible with the fluid being used.Reducer fittings shall be used for changes in pipeline sizes and strainer connection sizes.

F. **Unions shall be located adjacent to each screwed valve, trap, filter and strainer.**

G. **Valves:** Install at equipment to allow maintenance or isolation, and to establish proper and sequential operation of the complete system. Remove valve bonnets where valve construction permits removal when connecting valves by brazing to copper tubing. Install globe valves with stems horizontal where necessary to avoid trapping of fluid.

### 3.2 TESTING OF SYSTEMS

A. Test piping system hydrostatically using water not exceeding 100 deg. F. Conduct tests in accordance with the requirements of ANSI B31.1 and as follows. Test the piping system after the lines have been flushed and cleaned. Test piping system to 1½ times design pressure, but never exceed test pressure of any material included in the system. In all tests remove or valve off from the system gages, traps and other equipment which may be damaged by the tests before the tests are made. Install calibrated test pressure gauge in piping system to observe any loss in pressure. Maintain the required test pressure for a sufficient length of time to enable an inspection to be made of all joints and connections. Water for making test will be furnished by the Owner, but Contractor shall furnish pump, piping, hose, etc. Tests shall be made in presence of the Owner.

B. Design pressures of piping systems are listed in the individual piping tables found at the end of this section.

### 3.3 TEST AND INSPECTION OF GAS AND AIR LINES

A. Test and inspect all new piping work. Contractor shall furnish all equipment and apparatus necessary for tests. Contractor shall provide a temporary gasoline engine driven, oil-less compressor, nitrogen bottles or approved equal, capable of completing testing requirements specified in this section.

B. **Leak Tightness Tests:** After installation, pressurize system with clean, dry air or nitrogen at 1½ times the design pressure. Brush joints with soapy water solution to check for leaks. Install a calibrated test pressure gauge in piping system to observe any loss in pressure. Calibrate the test pressure gauge with a dead weight tester and certify by initial and date on dial before using. Maintain...
required test pressure for a minimum of 24 hours to enable inspection of joints and connections.

C. Test safety gas train control devices to demonstrate performance of their required function. Completely test system for compliance with specifications.

3.4 IDENTIFICATION

A. All piping and valves shall be identified, marked or tagged as specified in Section 23 05 53, "IDENTIFICATION".
### SYSTEM:
**NATURAL GAS (ABOVEGROUND)**

### PRESSURE:
**100 PSIG (PRESSURE TEST AT 150 PSIG)**

### TEMPERATURE:
**150 DEG. F**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SIZE (IN.)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPE</td>
<td>½ thru 1½</td>
<td>Carbon steel, STD weight, ASTM A106, Grade B seamless ANSI B36.10</td>
</tr>
<tr>
<td></td>
<td>2 thru 8</td>
<td>Carbon steel, STD weight, ASTM A106, Grade B, beveled ends, ANSI B36.10</td>
</tr>
<tr>
<td>TYPE OF JOINT</td>
<td>½ thru 1½</td>
<td>Socket weld</td>
</tr>
<tr>
<td></td>
<td>2 thru 8</td>
<td>Butt weld</td>
</tr>
<tr>
<td>FITTINGS</td>
<td>½ thru 1½</td>
<td>Forged carbon steel, ASTM A105 ANSI Class 3000 ANSI B16.11, socket weld.</td>
</tr>
<tr>
<td></td>
<td>2½ thru 8</td>
<td>Carbon steel, ASTM A234, Grade WPB, standard weight, ANSI B16.9, butt weld</td>
</tr>
<tr>
<td>NIPPLES</td>
<td>½ thru 1½</td>
<td>Carbon steel, ASTM A106, Grade B, Schedule 80, plain ends.</td>
</tr>
<tr>
<td>UNIONS</td>
<td>½ thru 1½</td>
<td>Forged carbon steel, ANSI Class 150, ASTM A105, socket weld, raised face ANSI B16.5.</td>
</tr>
<tr>
<td>FLANGES</td>
<td>½ thru 1½</td>
<td>Forged carbon steel, ANSI Class 150, ASTM A105, raised face, ANSI B16.5, threaded.</td>
</tr>
<tr>
<td></td>
<td>2 thru 8</td>
<td>Forged carbon steel, ANSI Class 150, ASTM A105, welding neck, standard bore raised face, ANSI B16.5.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EXCEPTION: Use flat face flanges when mating with flat face flanges on valves or equipment</td>
</tr>
<tr>
<td>GASKETS</td>
<td>½ thru 2½</td>
<td>1/16 in. thick, ANSI Class 150, ring type compressed synthetic fiber with SBR binder. (Use FF gaskets with FF flanges)</td>
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<tr>
<td></td>
<td></td>
<td>Approved Gaskets: Garlock &quot;Blue Guard&quot; style 3200 Chesterton 190</td>
</tr>
<tr>
<td>THREADED SEALANT</td>
<td></td>
<td>Teflon Ribbon ½ inch wide x 4 mils thick</td>
</tr>
</tbody>
</table>

Fosdick & Hilmer, Inc. © 2012  23 21 13 - 5  PIPING MATERIALS AND METHODS
### PIPING MATERIALS AND METHODS

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SIZE (IN.)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| BOLTS           |            | **Stud Bolts:** Carbon Steel  
ASTM A 307 Grade B  
Thread ANSI B1.1 Class 2A  

Heavy Hex Nuts: Carbon Steel  
ASTM A 563 Grade A  
Thread ANSI B1.1 Class 2B |
| PLUG VALVE      | ½ thru 8   | ANSI Class 200 CWP lubricated  
Body: Cast iron, ASTM A126, Class B  
Ends: F.F. flanged, ANSI B16.1  
Features: Regular pattern, lubricated plug, wrench operated. |
|                 |            | Approved Valves:  
Rockwell Nordstrom 115  
Powell  
Homestead |
| BALL VALVES     | ½ thru 8   | ANSI Class 150  
Body: Carbon steel, ASTM A216 WCB  
Stem: Carbon steel, ASTM A108 Type 215  
Seats and Seals: RPTFE  
Features: Blow-out proof stem, full bore design for maximum efficiency, full port |
|                 |            | Approved Valves:  
Apollo 88A-900 Series |

Note: Sealant required for plug valves shall be manufacturer’s suggested formula.
HOT WATER SUPPLY AND RETURN (HWS, HWR)
PRESSURE: 150 PSIG (PRESSURE TEST AT 225 PSIG)
TEMPERATURE: 200 DEG. F

<table>
<thead>
<tr>
<th>ITEM</th>
<th>SIZE (IN.)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIPE</td>
<td>½ thru 2</td>
<td>Copper tubing ASTM B 88 seamless hard drawn Type L plain ends</td>
</tr>
<tr>
<td></td>
<td>2½ thru 14</td>
<td>Carbon steel standard weight ASTM A106 seamless, Grade B ERW beveled ends ANSI B36.10</td>
</tr>
<tr>
<td>TYPE OF JOINT</td>
<td>½ thru 2</td>
<td>Copper solder joints</td>
</tr>
<tr>
<td></td>
<td>2½ thru 14</td>
<td>Butt weld</td>
</tr>
<tr>
<td>FITTINGS</td>
<td>½ thru 2</td>
<td>Copper ASTM B75 wrought solder joint pressure type ANSI B16.22 copper tubing ends</td>
</tr>
<tr>
<td></td>
<td>2½ thru 14</td>
<td>Carbon steel standard weight ASTM A234 Grade WPB ANSI B16.9, butt weld</td>
</tr>
<tr>
<td>UNIONS</td>
<td>½ thru 2</td>
<td>Copper ASTM B75 solder joint ends integral seats ANSI B16.22</td>
</tr>
<tr>
<td>FLANGES</td>
<td>½ thru 2</td>
<td>Wrought copper with solder ends</td>
</tr>
<tr>
<td></td>
<td>2½ thru 14</td>
<td>Weld neck forged steel ANSI Class 150 ASTM A105 standard bore. Raised face ANSI B16.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exception: Use flat faced flanges when mating with flat faced flanges on valves or equipment.</td>
</tr>
<tr>
<td>GASKETS</td>
<td>½ thru 14</td>
<td>⅛ in. thick ANSI Class 150 ring type, 316 stainless steel inner ring, carbon steel outer ring, 316L stainless steel winding strip, spiral wound</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approved Gaskets: Flexitallic style CGI with &quot;Flexite Super&quot; filler</td>
</tr>
<tr>
<td>THREAD Sealant</td>
<td></td>
<td>Teflon Ribbon ½ inch wide x 4 mils thick</td>
</tr>
<tr>
<td>BOLTS</td>
<td></td>
<td>Stud Bolts - Alloy steel ASTM A 193 Grade B7 Thread ANSI B1.1 Class 2A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy Hex Nuts: Alloy Steel ASTM A 194 Grade 2H Thread ANSI B1.1 Class 2B</td>
</tr>
<tr>
<td>ITEM</td>
<td>SIZE (IN.)</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BALL VALVES</td>
<td>½ thru 2</td>
<td>600 psig WOG rating&lt;br&gt;Body: Bronze ASTM B 584, alloy 844 extended stem&lt;br&gt;Trim: Chrome plated ball and stem&lt;br&gt;Seats and Seals: RTFE&lt;br&gt;Features: Blow-out proof stem&lt;br&gt;Ports: Full port flow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approved Valves: Apollo 82-100&lt;br&gt;Marwin 4666-RTTS&lt;br&gt;Stockham S-216-BR-RT&lt;br&gt;Watts B-6800</td>
</tr>
<tr>
<td>CHECK VALVES</td>
<td>¼ thru 2</td>
<td>ANSI Class 800&lt;br&gt;Body: Forged carbon steel ASTM A105&lt;br&gt;Trim: 13 percent chrome&lt;br&gt;Ends: Socket weld&lt;br&gt;Features: Swing type horizontal installation, bolted bonnet type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approved Valves: Vogt SW 4835&lt;br&gt;Bonney Forge HL-61-SW&lt;br&gt;RP&amp;C F99A</td>
</tr>
<tr>
<td></td>
<td>2½ thru 18</td>
<td>ANSI Class 150&lt;br&gt;Body: Cast carbon steel ASTM A216 Grade WCB&lt;br&gt;Trim: 13 percent chrome to hard facing&lt;br&gt;Ends: Flanged&lt;br&gt;Features: Bolted cap, disc swing type</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approved Valves: Crane 147 XU&lt;br&gt;Lunkenhemier 1572 W&lt;br&gt;Powell 1561</td>
</tr>
<tr>
<td>BUTTERFLY VALVES</td>
<td>2½ thru 12</td>
<td>250 WOG Rating&lt;br&gt;Body: Cast iron ASTM A126 Class B threaded lug pattern, extended neck&lt;br&gt;Disc: AISI type 316 stainless steel ASTM A351CF8M&lt;br&gt;Bearings: RFTE lined stainless steel&lt;br&gt;Stem: 416 Stainless steel&lt;br&gt;Seat: EPDM&lt;br&gt;Operator: Handwheel worm gear. 4” and smaller: lever operators.&lt;br&gt;Features: Bidirectional for dead-end service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approved Valves: Keystone figure 222</td>
</tr>
<tr>
<td>ITEM</td>
<td>SIZE (IN.)</td>
<td>DESCRIPTION</td>
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<tr>
<td>-----------</td>
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<td>-------------</td>
</tr>
<tr>
<td>Approved Valves: Keystone figure 602 Centerline DeZurick</td>
<td></td>
<td></td>
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<tr>
<td>STRAINERS  ¼ thru 18</td>
<td>Cast iron 250 lb. flanged &quot;Y&quot; pattern self-cleaning strainer ASTM A-278, .045 perforated stainless steel screen (alternate: Monel)</td>
<td></td>
</tr>
<tr>
<td>ITEM</td>
<td>SIZE (IN.)</td>
<td>DESCRIPTION</td>
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<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>PIPE</td>
<td>½ thru 1½</td>
<td>Carbon steel standard weight ASTM A 53 Grade A Type F ANSI B36.10</td>
</tr>
<tr>
<td></td>
<td>2 thru 14</td>
<td>Carbon steel standard weight, ASTM A 53 Grade B Type E beveled ends ANSI B36.10 except steam generator safety valve vent.</td>
</tr>
<tr>
<td></td>
<td>2½ thru 14</td>
<td>Spiral welded steel pipe conforming to ASTM A 211 with 0.172 inch wall thickness for safety valve vents</td>
</tr>
<tr>
<td>TYPE OF JOINT</td>
<td>½ thru 1½</td>
<td>Threaded NPT</td>
</tr>
<tr>
<td></td>
<td>2 thru 14</td>
<td>Butt weld</td>
</tr>
<tr>
<td>FITTINGS</td>
<td>½ thru 1½</td>
<td>Malleable iron ASTM A 197 ANSI Class 150 ANSI B16.3 threaded ends</td>
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<tr>
<td></td>
<td>2 thru 14</td>
<td>Carbon steel ASTM A 234 Grade WPB standard weight ANSI B16.9, butt weld</td>
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<td>NIPPLES</td>
<td>½ thru 1½</td>
<td>Carbon steel ASTM A 106 Grade B, Schedule 40 threaded both ends</td>
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<tr>
<td>UNIONS</td>
<td>½ thru 1½</td>
<td>Malleable iron ANSI Class 150 ASTM A 197 bronze to iron seats, threaded ends</td>
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<tr>
<td>THREAD SEALANT</td>
<td></td>
<td>Teflon ribbon ½ in. wide x 2 mils thick</td>
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<tr>
<td>DRIP PAN ELBOWS</td>
<td></td>
<td>Cast iron screwed NPT inlet Grinnell fig. 1538</td>
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<tr>
<td>BALL VALVE</td>
<td>¼ thru 2</td>
<td>600 psi. WOG rating \nBody: Bronze ASTM B-584 alloy 844, two piece extended stem \nBall: ANSI type 316 \nBall: ANSI type 316 stainless steel, blow-out-proof design \nSeats: Reinforced TFE \nEnds: Threaded \nPorts: Conventional \nApproval Valves: Apollo 70-100 Stockham S216-BR1-R-T Marwin 963-RTR Crane 9302</td>
</tr>
<tr>
<td>ITEM</td>
<td>SIZE (IN.)</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>GATE VALVES</td>
<td>¼ thru 2</td>
<td>ANSI Class 800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Body: Forged carbon steel ASTM A105</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trim: 13 percent chrome</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Features: OS&amp;Y, bolted bonnet, solid wedge disc</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approved Valves:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vogt SW12111</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RP&amp;C EF57D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bonney Forge HL-11-SW</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. This specification includes the provision of the following:

1. Air vents
2. Test plugs
3. Flexible connectors
4. Suction diffusers
5. Circuit setters
6. Thermometers
7. Pressure gauges
8. Gas Pressure Regulator

B. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

PART 2 - PRODUCTS

2.1 AIR VENTS

A. Provide automatic type air vents suitable for 150 psig water piping systems as manufactured by Hoffman no. 79, Dole Valve Company, Amtrol, Armstrong, or approved equal.

B. Pipe outlet of vent with ¼ in. type L copper tubing to discharge, as directed, or over floor drain. Provide ball valve at ½ in. connection to air vent.

C. Air vents for finned pipe radiation, convectors, cabinet heaters, and fan coil units shall be Dole Valve Co. no. 14, air vent with removable key.

D. Air vents for air coils shall be ¾ in. ball valves.

2.2 TEST PLUGS

A. Provide test plugs, ¼ in. or ½ in. NPT fitting of solid brass, capable of receiving either a pressure or temperature probe as manufactured by Pete’s Plug, Sisco Plugs, or approved equal.

B. Dual seal core shall be neoprene for temperatures to 1000 deg. F and be rated zero leakage from vacuum to 1000 psig.

C. Provide extension pipes for insulated piping.
2.3 FLEXIBLE CONNECTORS

A. Provide flexible connectors for all vertical in-line pump suction and discharge piping.

B. Flexible connectors shall be Mason Industries model MFEJ, Ethylene Corp., Metraflex, or approved equal. The flexible connection shall allow for the movements associated with the vibration of the pumps and shall be able to withstand a hydro pressure of each system listed in Section 23 21 13 “PIPING MATERIALS AND METHODS.”

C. Flexible connectors shall have ANSI Class 150, ANSI B16.5, ASTM A105, raised face flanges, with wire cables.

2.4 SUCTION DIFFUSERS

A. Provide suction diffusers as required by drawings on all pump suctions. Diffusers shall be Class 125, angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder with openings for pump protection as manufactured by Bell & Gossett, Mueller Steam, Armstrong, or approved equal.

B. Permanent magnet shall be located within flow stream and shall be removable for cleaning.

C. Orifice cylinder shall be equipped with a disposable fine mesh strainer, which shall be removed after system start-up.

2.5 CIRCUIT SETTERS

A. Each circuit setter valve shall have differential pressure read-out ports across valve seat area with read-out ports fitted with internal EPT insert and check valve. Valve bodies shall have ¼ inch NPT tapped drain/purge port.

B. Circuit setter valves 2 inch and smaller shall be bronze body with brass ball construction with glass and carbon filled TFE seat rings as manufactured by Bell & Gossett or approved equal.

C. Circuit setter valves 2½ inch and larger shall be cast iron construction with class 125 psi flanged connections suitable up to 175 psi working pressure and brass ball with glass and carbon filled TFE seat rings.

D. Circuit setter valves 4 inch and larger shall be fitted with bronze seat, replaceable bronze disc with EPDM seal insert and stainless steel stem. All circuit setter valves shall have memory stop feature to allow valve to be closed for service and then reopened to set point without disturbing balance position. Valves shall be leak-tight at full rated working pressure.
2.6 PRESSURE GAUGES

A. Pressure gauges shall be Ashcroft, Palmer Wahl, Ametek U.S. Gauge, or approved equal, with 4½ inch dial, flanged aluminum alloy case, and steel friction ring, all in black finish.

B. Dials shall be white coated iron with black figures and graduation lines with graduated scales, as indicated on plans.

C. Each gauge shall be liquid filled and provided with a ¼ inch ball valve for isolation by Apollo, Whitey, Hoke or approved equal.

D. Gauges shall be located so as to be easily read from the floor level.

E. Scale range shall be such that design operating point falls near the center of the scale range, with the total range from zero to approximately twice the design operating pressure.

2.7 THERMOMETERS

A. Provide red reading liquid in glass thermometers with 9 inch magnified column, Fahrenheit scale and lagging extension thermometer well. Thermometers shall be Ashcroft, Palmer Wahl, Weiss Instruments, or approved equal.

B. Thermometer wells shall be stainless steel.

C. Scale range shall be such that design operating point falls near the center of the scale of the range, with a total range from zero to approximately twice the design operating temperature.

2.8 GAS PRESSURE REGULATOR

A. Gas pressure regulator shall be capable of reducing incoming 1 PSI pressure to 4-7 inches to boiler. Direct operating type, self-regulating. Fisher Type 133L or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermometers on inlet and outlet of air handling unit coils and where indicated on drawings.

B. Install air vents at high points of the water systems, and at coils, heaters and finned radiation.

C. Circuit setters 3 inch and under shall be installed with a minimum length of 3 pipe diameters of unrestricted straight pipe upstream and 1 pipe diameter of unrestricted straight pipe downstream.
D. Circuit setters 4 inch and larger shall be installed with a minimum length of 5 pipe diameters of unrestricted straight pipe upstream and 2 pipe diameters of unrestricted straight pipe downstream.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. This specification covers the provision of the following:

1. Hot water primary pumps (P-2A, P-2B, and P-2C)

B. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

C. Refer to Section 23 21 24 “ELECTRIC MOTORS.”

PART 2 - PRODUCTS

2.1 VERTICAL IN-LINE PUMPS

A. General - Provide electric motor driven pumps as specified below.

B. Capacity and performance

1. See drawings for size and capacity of each unit.

C. Materials

1. Each pump shall be an Armstrong series 4300 or approved equal, split coupled vertical in-line centrifugal type, constructed in accordance with ANSI B73.2.

2. Construction shall be cast iron with equal size, ANSI Class 125 suction and discharge flanges with in-line suction and discharge nozzles, and having separate tapped flush line and pressure gauge connections.

3. Pump shall include cast iron, semi-open, statically and dynamically balanced impeller, stainless steel shaft and sleeve, lower carbon throttle bushing with balanced outside mechanical seal.

4. Maximum casing pressure rating shall be 175 psig.

5. John Crane, type 8B2 or approved equal outside balanced type mechanical seal with carbon rotating face, ceramic stationary seat and Viton secondary seal shall be provided to withstand the pumped fluid temperature and pressure. Where required provide an API Plan seal flush for mechanical seal cooling. Pump manufacturer shall provide one spare mechanical seal for each pump.
D. Motor

1. Pumps shall be provided with not less than pump horsepower listed on the drawings and shall be provided as specified in Section 23 21 24 “ELECTRIC MOTORS.”

2. Motor shall be squirrel cage induction type, P-base, with ODP enclosure and shall be connected to the pump through a high tensile aluminum, split spacer coupling to permit servicing of mechanical seal without disturbing pump, motor or electrical wiring. A guard shall protect the coupling.

3. Motor load shall not exceed the nameplate rating, not including the service factor, over the entire range of the pump curve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer’s instructions for pump mounting and startup.

B. Make transitions from pump suction and discharge connections to line sizes with reducers and long radius elbows or reducing elbows. Suction guides shall be provided for vertical inline pumps. Provide pipe stanchion supports under elbows at all horizontal pump connections to ensure that no weight is carried by pump casing.

C. Permanently support in-line pumps by the connecting piping only, not from the casing or the motor eye bolt.

D. Provide all drains required from pumps and baseplates to nearest floor drain. Provide air cock and drain connection on pump casing.

E. A qualified millwright shall align base mounted pumps prior to start-up.

F. Sequence of installation for base-mounted pumps:

1. Level and shim the unit base and grout to the concrete pad.

2. Shim the driver and realign the pump and driver. Correct axial, angular or parallel misalignment of the shafts.

3. Connect properly aligned and independently supported piping.

4. Recheck alignment.

3.2 STARTUP

A. Provide the services of a qualified factory representative upon completion of pump installations to check the completed installation before start-up, to place the pumps in operation, and to test and demonstrate pumps as required to obtain
a proper installation and successful operation of the equipment. Refer to commissioning pump specifications.

B. Factory representative shall also thoroughly instruct the Owner’s operating personnel in the proper operation of the equipment.

C. Factory representative shall conduct such operating tests as required to insure that the unit is operating in accordance with the specified performance. Such testing shall be performed as necessary to ascertain that the unit is in proper operation. Complete testing of all safety and control devices shall be performed. The factory representative shall submit a written report to the Owner containing all data recorded and a letter stating that the unit is operating properly. The Owner shall review the report and make a decision regarding the compliance of the unit with this specification. Suitable corrective action shall be made by the Contractor to insure compliance with the specifications, at no additional cost to the Owner.

D. Provide services of a factory service representative for not less than 4 eight hour days to perform the duties specified above for the pumps.

E. Verify that the piping system has been flushed, cleaned and filled.

F. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.

G. After several days operation, remove the disposable startup strainer in the suction diffuser.

H. Perform field mechanical balancing if necessary to meet specified vibration tolerance.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE

A. Electric motors shall be rated in accordance with NEMA standard MG-1, and shall be suitable for continuous operation at rated load at service conditions defined in the standard.

B. Size motors to meet the horsepower requirements of the driven unit at design conditions, including V-belt and/or drive and coupling losses which are incurred, without loading the motor beyond its nameplate horsepower rating. Motors shall also be sized to accelerate the driven load from zero to full rated speed in ten seconds or less under a full voltage start.

C. Size motors to be non-overloading under all possible conditions of operation.

D. Motors shall not be smaller than indicated on drawings or in the specifications, but may be larger to meet the above requirements.

E. If any manufacturer uses motors requiring larger NEMA size control equipment than motors shown, this Contractor shall be responsible for the extra cost for such control equipment.

F. Motors with V-belt drives shall be furnished with two-bolt adjustable motor bases.

G. Refer to Section 23 00 10 “BASIC MECHANICAL REQUIREMENTS.”

PART 2 - PRODUCTS

2.1 SINGLE PHASE MOTORS

A. Unless specifically noted otherwise, motors less than ½ HP shall be T-Frame, Design B, 1.25 service factor 115 VAC, 60 hz, single phase, capacitor start or permanent split capacitor, open drip-proof type with minimum class B insulation for 40 DEG. C ambient.

B. Motor efficiency shall be not less than 75 percent.

C. Single phase motors shall be Marathon, Baldor, Century or approved equal.

2.2 THREE PHASE MOTORS

A. Unless specifically noted otherwise, motors ½ HP and larger shall be 460 VAC, 60 Hz, three phase, NEMA B design, squirrel cage induction type, with open drip-proof construction, unless noted to be TEFC. Units shall be T-frame with minimum class B insulation designed for 40 deg. C ambient.
B. Motors shall have copper windings, steel or cast iron frames, and heavy duty, grease-lubricated, anti-friction bearings.

C. Motors shall have the following service factor:

<table>
<thead>
<tr>
<th>HP</th>
<th>Service Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ to 1 HP</td>
<td>1.25</td>
</tr>
<tr>
<td>1½ HP and larger</td>
<td>1.15</td>
</tr>
</tbody>
</table>

D. Motors shall be of the highest efficiency design available.

E. Minimum efficiency shall be based on motor size as follows:

<table>
<thead>
<tr>
<th>Motor Size</th>
<th>Minimum Full Load Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ to 1 HP</td>
<td>85%</td>
</tr>
<tr>
<td>1½ HP - 5 HP</td>
<td>90%</td>
</tr>
<tr>
<td>7½ HP and larger</td>
<td>92%</td>
</tr>
</tbody>
</table>

F. Motors shall be premium efficiency as defined by the National Electrical Manufacturers Association.

G. Motors used on variable frequency drives shall be inverter duty rated, Marathon “Blue Max”, no substitution.

H. Efficiency ratings shall be determined in accordance with NEMA Standard MG1-12.53a and MG1-12.53b.

I. Manufacturers shall be Reliance, Siemens, or General Electric. Baldor motors are not acceptable.

PART 3 - EXECUTION

3.1 Install according to manufacturer's instructions.

END OF SECTION
SECTION 23 52 16

CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Boilers have been prepurchased by the Owner. A copy of the submittal is attached to this spec section. This section details all other contractor requirements.

1.3 SCOPE

A. The installation of three hot water boilers.

PART 2 - PRODUCTS

2.1 VENTING

A. The exhaust vent must be UL Listed for use with Category III and IV appliances and compatible with operating temperatures up to 480°F, positive pressure, condensing flue gas service. UL-listed vents of Al 29-4C stainless steel must be used with boilers.

B. The minimum exhaust vent duct size for each boiler is eight-inch diameter.

C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the room.

D. Follow guidelines specified in manufacturer’s venting guide.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: A factory-authorized service representative shall inspect components, assemblies and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections: The contractor will perform the following tests and inspections and the manufacturer’s service representative shall assist:
1. Perform installation and startup checks according to manufacturer's written instructions.

2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.

3. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:
   1. The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following performance tests:
      a. A factory-authorized service representative shall inspect component assemblies and equipment installations, including connections, and conduct performance testing.
      b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
   2. Perform field performance tests to determine capacity and efficiency of boilers.
      a. Test for full capacity.
      b. Test for boiler efficiency at low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20 percent of full capacity. Determine efficiency at each test point.
3. Repeat tests until results comply with requirements indicated.

4. Provide analysis equipment required to determine performance.

5. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

6. Notify Engineer in advance of test dates.

7. Document test results in a report and submit to Engineer.

END OF SECTION
## CREST COMMERCIAL CONDENSING BOILER

**JOB NAME:** MC - Johnston Hall #2 Boiler Replacement  
**LOCATION:** Miami University, Oxford, Ohio  
**ARCH./ENGR.:** Fosdick & Hilmer Inc.  
**WHOLESALE:** Corken Steel Products  
**MECH. CONTRACTOR:**  
**MODEL NO.:** FBN2000  
**TYPE GAS:** Natural  
**Btu/hr INPUT:** 2,000,000  
**Btu/hr OUTPUT:** 1,840,000  
**NOTES:** 3 three boilers required

### SMART TOUCH FEATURES
- SMART TOUCH™ Touchscreen Operating Control
- Full-Color 8” Touchscreen LCD Display
- Built-in Casing and Sequencer for up to 8 Boilers
- Building Management System Integration with 0-10 VDC Input
- Modbus Communications
- Outdoor Reset Control with Outdoor Air Sensor
- Password Security
- Domestic Hot Water Prioritization
- Low Water Flow Safety Control & Indication
- Inlet & Outlet Temperature Readout
- Freeze Protection
- Service Reminder
- Time Clock
- Data Logging
- Hours Running, Space Heating
- Hours Running, Domestic Hot Water
- Battery Fail Safe
- Ignition Attempts
- Last 10 Lockouts
- Programmable System Efficiency Optimizers
- Night setback
- Anti-Cycling
- Outdoor Air Reset Curve
- Ramp Delay
- Boost Temperature & Time
- Three Pump Control
- System Pump
- Boiler Pump
- Domestic Hot Water Pump
- High-Voltage Terminal Strip
  - 120 VAC / 60 Hz / 1 Phase Power Supply System, Boiler Pump and DHW Pump Power
- Low-Voltage Terminal Strip
  - 24 VAC Auxiliary Device Relay
  - Auxiliary Operating Switch Contacts
  - Alarm on Any Failure Contacts
  - Runtime Contacts
  - DHW Thermostat Contacts
  - Unit Enable/Disable Contacts
  - System Sensor Contacts
  - DHW Tank Sensor Contacts
  - Outdoor Air Sensor Contacts
  - Cascade Contacts
  - 0-10 VDC BMS External Control Contacts

### STANDARD FEATURES
- 92% Thermal Efficiency (AHRD)
- Up to 99% Thermal Efficiency in Low Temperature Applications
- Modulating Burner with up to 25:1 Turndown
- Direct-Draft Ignition
- Low-Nox Operation
- Sealed Combustion
- Low Gas Pressure Operation
- Vertical or Horizontal Venting
- Category IV Venting up to 100 feet
- ASME "H" Stamped Heat Exchanger
- 316L Stainless Steel Fire Tubes
- 160 psi Working Pressure
- On/Off Switch
- Adjustable High Limit with Manual Reset
- Low-Water Cutoff with Manual Reset & Test
- High & Low Gas Pressure Switches w/Manual Reset
- Low Air Pressure Switches
- Condensate Trap w/ Blocked Drain Switch
- Drain Valve
- System Sensor
- Outdoor Air Sensor
- Inlet & Outlet Temperature Sensors
- High Voltage Terminal Strip
- Low Voltage Terminal Strip
- Downstream Gas Test Cocks
- 50 psig ASME Relief Valve
- Temperature & Pressure Gauge
- Zero Clearances to Combustible Materials
- 10-Year Limited Warranty (See Warranty for Details)
- 1-Year Warranty on Parts (See Warranty for Details)

### OPTIONAL EQUIPMENT
- Alarm Bell
- BMS Gateway
- Condensate Neutralization Kit
- SMART TOUCH PC Software
- Common Vent Kits
- Dual Fuel Gas Train

### ELECTRICAL OPTIONS
- 208V/3Ø/60Hz
- 240V/3Ø/60Hz
- 240V/3Ø/50Hz
- 480V/3Ø/60Hz

### CODES & REGISTRATIONS
- ANSI Z21.13/CSA Certified
- ASME certified, "H" Stamp / National Board
- California Code Compliant
- CSD1 / Factory Mutual / GE Gap Compliant
- South Coast Air Quality Management District Qualified
- Canadian Registration Number (CRN)
- AHR Certified
### CREST Heating Boiler Dimensions and Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Input MMBTU/HR Max</th>
<th>Input MMBTU/HR Thermal%</th>
<th>AHR Max</th>
<th>Output MMBTU/HR</th>
<th>NET Input MMBTU/HR</th>
<th>Turndown*</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBN1500</td>
<td>60</td>
<td>92.0%</td>
<td>1,500</td>
<td>1,380</td>
<td>1,200</td>
<td>25:1</td>
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<tr>
<td>FBN2000</td>
<td>80</td>
<td>92.0%</td>
<td>2,000</td>
<td>1,840</td>
<td>1,600</td>
<td>20:1</td>
</tr>
<tr>
<td>FBN2500</td>
<td>125</td>
<td>92.0%</td>
<td>2,500</td>
<td>2,360</td>
<td>2,000</td>
<td>16:1</td>
</tr>
<tr>
<td>FBN3000</td>
<td>150</td>
<td>92.0%</td>
<td>3,000</td>
<td>2,710</td>
<td>2,400</td>
<td>12:1</td>
</tr>
<tr>
<td>FBN3500</td>
<td>200</td>
<td>92.0%</td>
<td>3,500</td>
<td>3,220</td>
<td>2,800</td>
<td>11:1</td>
</tr>
</tbody>
</table>

**Notes:** Indoor installation only. All information subject to change. Change "N" to "L" for LP gas models. Low NOx on FBN2500 - FBN3500 models, consult factory.

*Turndown rate reduced on LP gas models.

### Venting Options

- [ ] Direct Vent Vertical
- [ ] Direct Vent Horizontal
- [ ] Vertical Vent with Sidewall Air Intake
- [ ] Sidewall Vent with Rooftop Air Intake
- [ ] Vertical Vent with Optional Room Air
- [ ] Sidewall Vent with Optional Room Air
**Product Scope:**

Provide 3 each – Lochinvar Crest Boiler model FBN Crest Boiler 2000 MBH input, 1,840 MBH output up to **92% thermal efficiency**, up to **99% thermal efficiency in low temperature applications**, burner with up to 25:1 modulation, outdoor reset w/sensor, 3 pump relay/freeze protection, contacts on any failure, inlet & outlet sensors, low water cut-off with manual reset, high & low gas pressure switches with manual reset, adjustable high limit w/manual reset, product service indicator and 50#/relief valve. SMART TOUCH Control for lead/lag sequencing of up to 8 boilers, pump control, 0-10Vdc input control, Modbus Communications, outdoor reset with outdoor air sensor domestic hot water prioritization, time clock, night setback, anti-cycling, firing controls to meet CSD-1/FM/GE Gap. 10 year limited warranty. **Note: Direct –vent air intake and exhaust runs using 8” Category IV AL29-4C Venting up to 100’air intake to be PVC (8”) up to 100’**.

Options included:

BacNet Communication Gateway  
Factory Start-up and demonstration of new system  
Warranty includes:  
- 10 year Heat Exchanger warranty against failure due to thermal stress, condensate corrosion, mechanical defects or workmanship.  
- 5 year Burner warranty  
- 2 year Control Panel warranty  
- All other components are conditionally guaranteed against any failure for 12 months of start-up date.
The boiler control system includes external system interface via BacNet MSTP

1. System start temperature feature
2. Pump delay timer
3. Auxiliary start delay timer
4. Auxiliary temperature sensor
5. Analog output feature to enable simple monitoring of temperature set point, inlet & outlet temperature or fire rate.
6. Remote interlock circuit
7. Delayed interlock circuit
8. Fault relay for remote fault alarm
9. The boiler control panel includes hard-wired start/stop.
10. The boiler control panel includes a hard-wired interlock for control of combustion air dampers.
11. The boiler control system will allow a remote set-point input via the BacNet MSTP.
12. Manual designation of lead boiler and last boiler.
13. Lead boiler rotation at user-specified time interval.
14. Delay the firing/shutting down of boilers when header temperature within a predefined dead band.
15. When set on Internal Set point Mode, temperature control set point on the shall be fully field adjustable from 50°F to 190°F in operation. When set on Indoor/Outdoor Reset Mode, the controller will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the controller will operate the plant to vary header temperature set point linearly as an externally applied 4-20 ma signal is supplied.
# 3 Memory Map

## Primary Data Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Data Type</th>
<th>Read / Write</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrete Inputs</td>
<td>Single Bit</td>
<td>Read Only</td>
</tr>
<tr>
<td>Coils</td>
<td>Single Bit</td>
<td>Read / Write</td>
</tr>
<tr>
<td>Input Registers</td>
<td>16-Bit Word</td>
<td>Read Only</td>
</tr>
<tr>
<td>Holding Registers</td>
<td>16 Bit Word</td>
<td>Read / Write</td>
</tr>
</tbody>
</table>

## Crest Boiler Memory Map

<table>
<thead>
<tr>
<th>Address</th>
<th>Description</th>
<th>Default</th>
<th>Unit</th>
<th>Min.</th>
<th>Max.</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>00001</td>
<td>Boiler Enable</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>00005</td>
<td>Tank Thermostat</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10001</td>
<td>Manual Reset High Limit</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10002</td>
<td>Flow Switch</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10003</td>
<td>Gas Pressure Switch</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10004</td>
<td>Louver Proving Switch</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10005</td>
<td>Blower Proving Switch 1</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10006</td>
<td>Blocked Drain Switch</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10008</td>
<td>Flame 1</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10009</td>
<td>Enable</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10010</td>
<td>Tank Thermostat</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10011</td>
<td>Blocked Flue</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10013</td>
<td>Blower Proving Switch 2</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10021</td>
<td>Flue Damper Proving Switch</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10023</td>
<td>Flame 2</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10033</td>
<td>Run-time Contacts</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10034</td>
<td>Alarm Contacts</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10035</td>
<td>SH Pump</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10036</td>
<td>HWG Pump</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10037</td>
<td>Louver Relay</td>
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<td>1=ON / 0=OFF</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10038</td>
<td>Gas Valve 1</td>
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<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10039</td>
<td>System Pump</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10044</td>
<td>Vent Damper Relay</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10046</td>
<td>Gas Valve 2</td>
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<td>1=ON / 0=OFF</td>
<td>0</td>
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<td>1</td>
</tr>
<tr>
<td>10049</td>
<td>Blower #1 Power</td>
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<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10050</td>
<td>Blower #2 Power</td>
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<td>1=ON / 0=OFF</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10051</td>
<td>Spark Igniter</td>
<td>0</td>
<td>1=ON / 0=OFF</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
# 3 Memory Map

## Crest Boiler Memory Map

<table>
<thead>
<tr>
<th>Address</th>
<th>Description</th>
<th>Default</th>
<th>Unit</th>
<th>Min.</th>
<th>Max.</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>30001</td>
<td>Discrete Inputs 1 - 16</td>
<td>0</td>
<td>NA</td>
<td>0</td>
<td>65535</td>
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<tr>
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<td>1</td>
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<td>%</td>
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<td>800</td>
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<td>800</td>
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<td>Boiler Pump Speed Out</td>
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<td>40003</td>
<td>0-10 Volt Input / Rate Command / Setpoint Command</td>
<td>0</td>
<td>%</td>
<td>0</td>
<td>100</td>
<td>1</td>
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<tr>
<td>40004</td>
<td>Tank Setpoint</td>
<td>0</td>
<td>Degrees Celsius</td>
<td>0</td>
<td>87.5</td>
<td>0.5</td>
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<td>40005</td>
<td>Tank Temperature</td>
<td>0</td>
<td>Degrees Celsius</td>
<td>-20</td>
<td>130</td>
<td>0.1</td>
</tr>
<tr>
<td>40006</td>
<td>Outdoor Temperature</td>
<td>0</td>
<td>Degrees Celsius</td>
<td>-40</td>
<td>60</td>
<td>0.1</td>
</tr>
<tr>
<td>40007</td>
<td>System Supply Temperature</td>
<td>0</td>
<td>Degrees Celsius</td>
<td>-20</td>
<td>130</td>
<td>0.1</td>
</tr>
<tr>
<td>40008</td>
<td>System Return Temperature</td>
<td>0</td>
<td>Degrees Celsius</td>
<td>-20</td>
<td>130</td>
<td>0.1</td>
</tr>
</tbody>
</table>

## Configuration Bits

Address 40001 contains configuration bits sent from the BAS to the boiler. These bits tell the boiler to use its own internal inputs, or inputs from the BAS. When a bit is set to 1, the boiler will ignore the corresponding value contained internally, and expect the BAS to write that value into the Holding Registers. The configuration bits are as follows:

- Bit 0 (LSB): Boiler Enable
- Bit 1: Tank Thermostat
- Bit 2: Rate Command / 10 - 10V Input / Setpoint Command
- Bit 3: Tank Setpoint
- Bit 4: System Supply Temperature
- Bit 5: Outdoor Temperature
- Bit 6: Tank Temperature
- Bit 7: System Return Temperature
- Bit 8 - 15: Not Used (Default = 0)
Hydronic piping (continued)

Circulator sizing

The Crest heat exchanger does have a pressure drop, which must be considered in your system design. Refer to the graph in FIG. 5-1 for pressure drop through the Crest heat exchanger.

![Figure 5-1 Pressure Drop vs. Flow](image)

Table 5A Sizing Information for Temperature Rise Applications, 20°F, 40°F and 60°F

<table>
<thead>
<tr>
<th>Model</th>
<th>BOILER CONNECTION SIZE</th>
<th>20°F</th>
<th>40°F</th>
<th>60°F</th>
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<td></td>
<td>GPM</td>
<td>FT/HD</td>
<td>GPM</td>
<td>FT/HD</td>
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<tr>
<td>FB 1500</td>
<td>4&quot;</td>
<td>138</td>
<td>3.4</td>
<td>69</td>
</tr>
<tr>
<td>FB 2000</td>
<td>4&quot;</td>
<td>184</td>
<td>4.1</td>
<td>92</td>
</tr>
<tr>
<td>FB 2500</td>
<td>4&quot;</td>
<td>230</td>
<td>4.6</td>
<td>115</td>
</tr>
<tr>
<td>FB 3000</td>
<td>4&quot;</td>
<td>277</td>
<td>5.6</td>
<td>138</td>
</tr>
<tr>
<td>FB 3500</td>
<td>4&quot;</td>
<td>323</td>
<td>7.5</td>
<td>161</td>
</tr>
</tbody>
</table>

[Based on 92% AHRI Efficiency]

**NOTICE** The pressure drop reflected in FIG. 5-1 is for the boiler only. Additional allowances must be made for piping, especially if sizing pumps for Primary/Secondary applications.

**NOTICE** It is required that boiler piping systems utilize Primary/Secondary or Full Flow configurations as shown in FIG.'s 5-2 thru 5-5. The use of other boiler piping configurations could result in improper building and system flow rates leading to inadvertent boiler high limit shutdowns and poor system performance.
<table>
<thead>
<tr>
<th>WATER</th>
<th>FB-1500</th>
<th>FB-2000</th>
<th>FB-2500</th>
<th>FB-3000</th>
<th>FB-3500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallon Capacity</td>
<td>96</td>
<td>122</td>
<td>161</td>
<td>181</td>
<td>215</td>
</tr>
<tr>
<td>Heating Surface (sq. ft.)</td>
<td>119.0</td>
<td>157.0</td>
<td>195.0</td>
<td>237.0</td>
<td>272.0</td>
</tr>
<tr>
<td>Inlet Water Connection</td>
<td>4&quot; Flanged</td>
<td>4&quot; Flanged</td>
<td>4&quot; Flanged</td>
<td>4&quot; Flanged</td>
<td>4&quot; Flanged</td>
</tr>
<tr>
<td>Outlet Water Connection</td>
<td>4&quot; Flanged</td>
<td>4&quot; Flanged</td>
<td>4&quot; Flanged</td>
<td>4&quot; Flanged</td>
<td>4&quot; Flanged</td>
</tr>
<tr>
<td>Drain</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
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<tr>
<td>Maximum Flow Rate</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
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<tr>
<td>Minimum Flow Rate</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>20°F ΔT Water Flow (GPM)</td>
<td>138.0</td>
<td>184.0</td>
<td>230.0</td>
<td>277.0</td>
<td>323.0</td>
</tr>
<tr>
<td>Head Loss (ft. of H.O.)</td>
<td>3.4</td>
<td>4.1</td>
<td>4.6</td>
<td>5.6</td>
<td>7.5</td>
</tr>
<tr>
<td>40°F ΔT Water Flow (GPM)</td>
<td>69.0</td>
<td>92.0</td>
<td>115.0</td>
<td>138.0</td>
<td>161.0</td>
</tr>
<tr>
<td>Head Loss (ft. of H.O.)</td>
<td>1.5</td>
<td>1.6</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Max. Working Pressure (PSI)</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
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<tr>
<td># of Relief Valves</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Relief Valve Size</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
<td>2&quot;</td>
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<td>Relief Valve Rating (MBH)</td>
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<td>3,075,000</td>
<td>3,075,000</td>
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<td>Relief Valve Pressure Rating (PSI)</td>
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<td>GAS</td>
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<tr>
<td>BTU/Hr Input</td>
<td>1,500,000</td>
<td>2,000,000</td>
<td>2,500,000</td>
<td>3,000,000</td>
<td>3,500,000</td>
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<td>BTU/Hr Output (High Fire)</td>
<td>1,380,000</td>
<td>1,840,000</td>
<td>2,300,000</td>
<td>2,760,000</td>
<td>3,220,000</td>
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<tr>
<td>BTU/Hr Output (Low Fire)</td>
<td>55,200</td>
<td>73,600</td>
<td>115,000</td>
<td>138,000</td>
<td>184,000</td>
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<td>Horse Power (Input)</td>
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<td>55</td>
<td>69</td>
<td>82</td>
<td>96</td>
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<td>Inlet Connection</td>
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<tr>
<td>Max. Inlet Pressure, Hot Water</td>
<td>16&quot; w.c.</td>
<td>16&quot; w.c.</td>
<td>16&quot; w.c.</td>
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<td>Min. Inlet Pressure, Hot Water</td>
<td>6&quot; w.c.</td>
<td>4&quot; w.c.</td>
<td>4&quot; w.c.</td>
<td>4&quot; w.c.</td>
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<tr>
<td>Max. Inlet Pressure, Low Water</td>
<td>14&quot; w.c.</td>
<td>14&quot; w.c.</td>
<td>14&quot; w.c.</td>
<td>14&quot; w.c.</td>
<td>14&quot; w.c.</td>
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<tr>
<td>Min. Inlet Pressure, Low Water</td>
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<td>4&quot; w.c.</td>
<td>4&quot; w.c.</td>
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<td>Rear</td>
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<td>Stainless Steel</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
<td>Stainless Steel</td>
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</table>

* Electrical - For alternate voltages and amp draws, please consult the factory or the installation and operation manual.

Lochnivar Corporation • 300 Maddox Simpson Pkwy • Lebanon, TN 37089 • 615-889-8900 / Fax: 615-547-1000

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FBN-PS-06
## ELECTRICAL SPECIFICATIONS INDEX

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<td>26 40 60</td>
<td>MINOR ELECTRICAL DEMOLITION</td>
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PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Electrical Requirements specifically applicable to all Division 26 Sections. These are in addition to the requirements of Division 1 - General Requirements.

1.2 FORM OF SPECIFICATIONS

A. These Specifications and the notes on the drawings are of the brief type and include incomplete sentences. Omission of words or phrases such as "The Contractor shall", "as noted on Drawings", "furnish and install", "a", "an", "the", "and", "of", and "all", are intentional. Omitted words or phrases shall be supplied by inference in same manner as they are when a "note" occurs on Drawings. Words "shall be", "shall have", "will be", "will have" or "will" shall be supplied by inference where a colon (:) is used within sentences or phrases.

B. Whenever words "approved", "satisfactory" "directed", "submitted", "inspected", "referred" or similar words or phrases are used, it shall be assumed that word "Engineer" follows the verb as object of the verb, such as "approved by the Engineer" and "submitted to the Engineer".

C. The word "provide" shall mean furnish and install. The word "approved" shall mean approved in writing by the Engineer. The phrase "as shown" shall mean as shown on the drawings. The phrase "this work" refers to work included in this Section of the specifications and on the associated drawings. "This contractor" refers to the contractor for this work.

1.3 SCOPE OF WORK

A. Provide labor, equipment, and materials necessary for the installation of the work specified herein and/or shown on the drawings. Labor shall be performed by qualified tradesmen. Equipment and materials shall be new and of manufacturers most recent model or type, installed in a neat workmanlike manner.

B. Systems and equipment included in this work shall be provided such that they are complete and operable. Provide all work, including work of other trades (e.g. concrete, carpentry, etc.) required to render systems and equipment complete and operable, unless such items are specifically included in the work of another contractor, as defined by the contract documents. Work other than that normally performed by the electrical trades shall be performed by a tradesman or subcontractor approved by the Construction Manager. Work of other trades included in this contract shall comply with the applicable Sections of these Specifications.

C. Examine the drawings and specifications for this branch of the work and all the drawings and specifications for the other branches of the work. Visit the site to become familiar with existing conditions. Attend pre-bid meetings and submit
requests for clarification in writing. Read answers to requests for clarification submitted by all contractors. Submitting a bid signifies that all conditions which have a bearing in any way on the manner of providing the work are known and included in the bid.

D. This contract includes work made necessary by field conditions that may not be shown or described in the Contract Documents but that are apparent during an inspection of the construction site.

E. Coordinate this work with that of all other trades that affect or are affected by this work. Cooperate with all other trade contractors to assure the steady progress of the work in accordance with the Construction Schedule.

F. The accompanying drawings are diagrammatic representations of the work to be done. Do not scale the drawings to determine exact locations or distances. Refer to dimensioned drawings and take field measurements to make these determinations.

G. Electrical Drawings and Specifications complement each other. Furnish all material and labor called for in one even if not specifically mentioned in both. Refer any conflict between specifications and drawings to Engineer for clarification. Where resolution of a conflict is not known at the time of bidding, Contractor shall include the cost the cost of the more expensive scope of work. Furnish material and labor necessary to complete work which is a component part of and usually included in work of similar character.

H. Engineer and Owner reserve the right to make minor changes in location of conduit, busway and equipment up to time of rough-in, without additional cost to Owner.

I. Install and connect equipment, services and material in accordance with best engineering and construction practice, and in accordance with manufacturer's written instructions and recommendations. Provide complete electrical connections, controls, etc., recommended by manufacturer or required for proper operation of the equipment.

J. Plan all work in buildings, including alterations to existing facilities and connection to existing services, to permit carrying on of normal building functions. When it is deemed necessary to interrupt a service, Owner will select time deemed by him to be least disruptive to normal building functions. But for bidding purposes only, assume such work as being done during normal working hours.

K. Provide temporary electric work, where necessary, to maintain existing building functions.

1.4 ACCEPTABLE PRODUCTS AND BASIS OF DESIGN

A. Wherever in the Contract Documents products are specified by manufacturers' names, base bids on the named products. Where more than one manufacturer's name is mentioned, the first listed establishes the standard and basis of design for that product. If a product of a manufacturer other than that listed first is used, it must be the equivalent of the one listed first. If revisions in equipment layouts,
wiring and conduit connections, etc., are required by other named products or approved substitutions, the cost of engineering and installing such revisions will be considered during bid evaluation.

B. The inclusion of a manufacturer’s name in the specifications does not imply that all of the manufacturer's standard products and options are acceptable. Manufacturer's shall modify their standard offerings, if necessary, to comply with the documents.

1.5 SUBMITTALS

A. Submit shop drawings for review by Engineer showing fabrication details, equipment configuration, dimensions, finish details, and connection details. Provide drawings of sufficient detail to indicate all components and critical dimensions. Do not release equipment for fabrication until Engineer affixes his stamp to the drawings indicating "No Exceptions Noted."

B. Stamp, initial and date submittals before submitting them for Engineer's review. Submittals shall be marked to show specification reference including section and paragraph numbers. Contractor’s stamp shall be taken as indication that the Contractor has reviewed the submittal and certifies that it complies with the contract documents and is suitable for the job requirements. Engineer's review will not be a through review for contract compliance, and no change in the contract requirements shall be inferred from the Engineer's notations, or affixing of the "No Exceptions Noted" stamp to a submittal.

C. Product data shall indicate type of materials, dimensions, weights, performance, electrical characteristics, and finishes of all components.

D. Submit samples of products or materials if requested to do so.

E. Include submittals for the products specified in the following sections:

1. 26 27 26 Wiring Devices
2. 26 28 16.20 Enclosed Switches
3. 26 29 13 Enclosed Controllers
4. 26 30 25 Electric Motors
5. 26 51 13 Interior Luminaires

F. Engineer will mark-up, stamp, and return a minimum of three (3) copies of shop drawings. Where additional copies are required, Contractor shall provide a reproducible drawing or catalog cut sheets that can be copied.

1.6 REGULATORY REQUIREMENTS

A. Obtain permits, and request inspections from authorities having jurisdiction.

B. Provide evidence that electrical equipment and materials meet the standards of Underwriter Laboratories, Inc. (UL). The listing Mark or Classification Marking of UL displayed on the equipment will be accepted as evidence of such compliance. Third party certification, by a testing agency approved by the authority having jurisdiction, shall be provided if UL certification is not available.
C. Work shall comply with the following codes, standards and requirements, as a minimum, where applicable. If no edition or date is listed, the latest published edition shall be used.

1. NFPA 70 - National Electrical Code.
2. OBBC - Ohio Basic Building Code.
3. OSHA - Occupational Safety and Health Act
4. UL - Underwriters Laboratories, Inc.
6. FM/IRI - Factory Mutual/Industrial Risk Insurers requirements.

1.7 PROJECT/SITE CONDITIONS

A. Install work in locations shown on drawings, unless prevented by project conditions. Refer to Architectural reflected ceiling plans for exact location of light fixtures.

B. Prepare 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 WEATHERPROOF EQUIPMENT

A. Equipment installed outdoors, or in locations exposed to the elements, or adjacent to wash down areas shall be of weatherproof, rain-tight construction, whether or not so indicated in the drawings. Enclosures shall be NEMA 4X.

1.9 LOCKS

A. All electrical cabinets and control panels furnished under this contract shall be keyed alike. Contractor shall furnish 3 keys per cabinet installed to the Owner.

1.10 EQUIPMENT PADS

A. Provide 4-inch (nominal) high concrete equipment pads for floor mounted electrical equipment where noted on drawings.

B. Pads shall be 4 inches larger than outside dimensions of equipment and edges shall be chamfered.

C. Concrete shall be ASTM C150, Type I or II and shall have a minimum compressive strength of 3,000 PSI at 28 days after pouring.

D. Mix shall be very dense so as to be waterproof after setting.

E. Level equipment with steel shims after installation.

1.11 MECHANICAL EQUIPMENT WIRING

A. Motors for equipment will be furnished and installed by the Mechanical Contractor. Electrical connections to all motors shall be provided by the Electrical
B. Motor controls shall be provided by the Electrical Contractor, unless otherwise noted, at the location shown. Electrical Contractor shall provide power connections to each motor controller and motor feeders from the load side of controllers and switches to motors, control panels, etc., as shown. Refer to drawings for feeder sizes and loads to be connected.

C. All controls shall operate at 120 VAC, unless otherwise indicated.

1.12 PARTITION BLOCKING

A. All required blocking and backing in partition construction for installation of electrical panels, backboxes, etc., shall be provided by the Electrical Contractor in coordination with the Partition Contractor.

1.13 PENETRATIONS – FLOORS AND WALLS

A. If penetration of floors and walls are required for work under this contract, the Electrical Contractor shall obtain the approval of the Construction Manager before any cutting or core drilling is done. Openings shall be no larger than necessary.

B. For conduit penetrations, core drill holes through existing concrete construction and provide “Pro Set Systems” penetration sleeves. Fill space between conduit and sleeve with ceramic fiber insulation for rated floors and walls. Fill space between conduit and sleeve with 0.75 PF fiberglass for all other walls to reduce sound transmission. Install penetration sleeves in accordance with manufacturer’s recommendations.

C. Provide Beacor split plates around conduits where they pass through walls, floors or ceiling in exposed areas.

1.14 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, partitions, etc., required for the installation of this work in a neat and careful manner. Openings shall be no larger than required to install the services.

B. Cutting shall be kept to a minimum. Obtain approval of Construction Manager before cutting or drilling.

C. Replace and repair any ductwork, conduit, piping, etc., that is damaged during cutting or drilling.

D. Cooperate with the other contractors to insure that openings of the proper size and location are provided for all work.

E. Patching around openings cut by this contractor or provided by others for him shall be done in a neat and workmanlike manner. Patching shall be done by an approved qualified contractor, but shall be paid for by this contractor. Finished patching shall retain fire and smoke ratings of cut partitions and shall match...
surrounding finish. Refer to the specification section titled “Firestopping,” for requirements for smoke- and fire-proofing of penetrations. “Firestopping” applies in its entirety to this work.

1.15 PAINTING

A. Equipment having factory finishes shall be touched up by this contractor wherever finish is damaged, using matching paint obtained from the equipment manufacturer.

B. Equipment that arrives at the job site with only a prime coat shall be painted with two coats of oil based paint of approved color.

1.16 AS BUILT AND RECORD DRAWINGS

A. Refer to specification section titled “Project Record Documents” of the Contract Documents.

B. Keep a set of the contract and coordination drawings at the job site on which a running record of changes in routing of services and location of equipment shall be kept in a neat and legible manner. Changes shall be made using a red pen or pencil. Engineer shall require evidence that “as built” drawings are up to date prior to approval of pay requests.

C. At the completion of the job, all changes required as a result of coordination shall be incorporated by the contractor, into the AutoCAD drawings developed by the Engineer. While the “as-built” drawing coordination effort may be done manually, the record drawings shall be done in AutoCAD, version 2010. One copy each of the record drawings shall be given to the Engineer and to the Owner. Two copies of all AutoCAD files shall be given to the Engineer on CD-ROM. The “as-built” drawings shall be scanned as red-line PDF files and two copies shall be given to the Engineer on CD-ROM.

1.17 COORDINATION DRAWINGS

A. Sheetmetal Contractor shall provide fabrication drawings to each Contractor. Electrical Contractor shall show his work on these drawings and coordinate his work with the other trades. Sign off and date shall be included by each Contractor.

1.18 CLEAN UP

A. Remove daily trash and debris caused by this work and dispose of off site. Keep emergency egress paths clear at all times. Sweep floors and remove debris from hidden surfaces above drop ceilings daily in work areas.

1.19 WARRANTY

A. All equipment, labor, and material shall have one year warranty from date of substantial completion unless otherwise specified. In addition, extend
manufacturer’s warranties that exceed one year to Owner. Keep work included under this contract, and each and every part thereof, in perfect condition, usual wear excepted, during warranty period and remedy, without expense to the Owner, any and all defects, whether in material, workmanship, or operation, that may become apparent during this period.

1.20 EQUIPMENT RECEIVING AND HANDLING

A. Contractor-Furnished, Contractor-Installed Equipment:

For all new equipment for which the Contractor is responsible, he shall receive equipment on site, remove from shipping materials, inspect for damage, verify that all components are provided, convey equipment into position, and install in accordance with the Contract Documents. Report any damage to equipment immediately. Damaged items shall be replaced by the equipment supplier, or the responsible party.

B. Owner-Furnished, Contractor-Installed Equipment:

Prior to bidding, the Construction Manager shall assign responsibility for specific Owner-furnished equipment to various Contractors. For all equipment for which the Contractor is responsible, based upon said assignments, he shall receive equipment on site, remove from shipping materials, inspect for damage, verify that all components are provided, convey equipment into position, and install in accordance with the Contract Documents. Report any damage to equipment immediately. Damaged items shall be replaced by the equipment supplier, or the responsible party.

1.21 COMMISSIONING OF SYSTEMS

A. Each contractor shall be required to test and demonstrate the operation of all systems and equipment (for which he is responsible) in the presence of the Owner, Engineer, and Construction Manager, and to make adjustments and system modifications as required until systems and equipment reliably meet required operational criteria. Refer to specification section titled “Commissioning,” for commissioning requirements.

END OF SECTION
SECTION 26 01 90

ELECTRICAL TESTING

PART 1 - GENERAL

1.1 GENERAL SCOPE

A. The contractor shall engage the services of an independent testing firm for the purpose of performing inspections and tests as herein specified.

B. The testing firm shall provide all material, equipment, labor and technical supervision to perform such tests and inspections.

C. The purpose of these tests are to assure that all tested electrical equipment, both contractor and Owner supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

D. Equipment to be inspected and tested is as follows:

1. Building wire, cable, and bus duct
2. Electric motors
3. Enclosed motor controllers
4. Enclosed circuit breakers
5. Safety disconnect switches
6. Panelboards
7. Transformers
8. Motor control centers

1.2 RELATED SECTIONS

A. Section 26 05 19 - Building Wire and Cable
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
C. Section 26 28 16.20 - Enclosed Switches
D. Section 26 29 13 - Enclosed Controllers

1.3 COPYRIGHT

A. Portions of this Section are copyright 1993 by InterNational Electrical Testing Association, P.O. Box 687, 231 Red Rocks Vista Drive, Morrison, CO 80465. Do not reproduce without providing notice of copyright.

1.4 REFERENCES

A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:
1. National Electrical Manufacturer’s Association – NEMA
3. Institute of Electrical and Electronic Engineers – IEEE
6. State and local codes and ordinances
7. Insulated Cable Engineers Association – ICEA
8. Association of Edison Illuminating Companies – AEIC
9. Occupational Safety and Health Administration – OSHA

   a. ANSI/NFPA 70: National Electrical Code
   b. ANSI/NFPA 70B: Electrical Equipment Maintenance
   c. ANSI/NFPA 70E: Electrical Safety Requirements for Employee Workplaces
   d. ANSI/NFPA 78: Lightning Protection Code

B. All inspections and tests shall utilize the following references:

   1. Project design specifications
   2. Project design drawings
   4. Manufacturer’s instruction manuals applicable to each particular apparatus
   5. Project list of equipment to be inspected and tested

1.5 QUALIFICATIONS

A. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations and systems.

C. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services.

D. The testing firm shall submit proof of the above qualifications with bid documents, when requested.

E. The terms used within, such as test agency, test contractor, testing laboratory, or contractor testing company, shall be construed to mean the testing firm.
1.6 DIVISION OF RESPONSIBILITY

A. The contractor shall perform routine insulation-resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.

B. The contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. The testing firm shall notify the Engineer prior to commencement of any testing.

E. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported to the Engineer.

F. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

G. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:

   a. Occupational Safety and Health Act
   b. Accident Prevention Manual for Industrial Operations, National Safety Council
   c. Applicable state and local safety operating procedures
   d. Owner’s safety practices
   e. National Fire Protection Association - NFPA 70E
   f. American National Standards for Personnel Protection

2. All tests shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.

3. The testing firm shall have a designated safety representative on the project to supervise the testing operations with respect to safety.

1.7 GENERAL

A. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.

2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average or RMS sensing and may include or exclude the DC component. When the variable contains harmonics or dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring
RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.

3. Field test metering used to check power system meter calibration must have an accuracy higher than of the instrument being checked.

4. Accuracy of metering in test equipment shall be appropriate for the test being performed.

5. Waveform and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

B. Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
   a. Maintained in good visual and mechanical condition
   b. Maintained in safe operating condition

2. Test equipment should have operating accuracy equal to, or better than, the following limits:
   a. Portable multimeters should be true RMS measuring.
   b. Multimeters should have the following accuracy limits, or better:
      1) AC voltage ranges: .75% +/-3 last single digits @ 60 Hz
      2) AC current ranges: .90% +/-3 last single digits @ 60 Hz, including adapters, transducers
      3) DC voltage ranges: .25% +/-1 last single digit
      4) DC current ranges: .75% +/-1 last single digit
      5) Resistance ranges: .50% +/-1 last single digit
      6) Frequency range: .10% +/-1 last single digit @ 60 Hz
   c. Clamp-on ammeters: AC current +/-3% of range +/-1 last single digit @ 60 Hz
   d. Dissipation/power factor field equipment
      1) +/-0.1% power factor for power factor values up to 2.0%
      2) 5% of the reading for power factor values above 2.0%
   e. Low-range DC resistance equipment: 1.0% of reading, +/-2 last single digits
   f. Transformer turns-ratio test equipment: 0.5% or better @ 60 Hz
   g. Ground electrode test equipment: +/-2% of range
   h. Insulation test sets: 0-1000 VDC +/-20% of reading at mid-scale
i. Electrical load survey equipment
   1) +/-5% total error, including sensors
   2) 1% resolution
   3) Current transformers +/-2% of range @ 60 Hz
   4) Voltage transformers +/-0.5% of range @ 60 Hz

j. Liquid dielectric strength test equipment: +/-2% of scale

k. Infrared scanning equipment: sensitivity of 2 degrees

l. Phase shifting equipment: +/-1.0 degrees over entire range

m. High-current test equipment: +/-2% of range

n. DC high potential test equipment: +/-2% of full scale

o. AC high potential test equipment (60 Hz): +/-2% of full scale

C. Test Instrument Calibration

1. The testing firm shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instruments shall be calibrated in accordance with the following frequency schedule:
   a. Field instruments: 6 months maximum
   b. Laboratory instruments: 12 months
   c. Leased specialty equipment: 12 months (Where accuracy is guaranteed by lessor)

4. Dated calibration labels shall be visible on all test equipment.

5. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

6. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.

7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

D. Test Report

1. The test report shall include the following:
   a. Summary of project
b. Listing of equipment tested  
c. Test results  
d. Recommendations

2. Furnish three copies of the complete report to the Engineer.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 INSPECTION AND TEST PROCEDURES

A. Cables - Low-Voltage - 600V Maximum

1. Visual and Mechanical Inspection

a. Inspect cables for physical damage and proper connection in accordance with single-line diagram.

b. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.

c. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

2. Electrical Tests

a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.

b. Perform continuity test to insure proper cable connection.

3. Test Values

4. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.

B. Air Switches - Low-Voltage

1. Visual and Mechanical Inspection

a. Compare equipment nameplate information with single-line diagram.

b. Inspect for physical and mechanical condition.

c. Check for proper anchorage and required area clearances.
d. Perform mechanical operation tests.

e. Verify fuse sizes and types are in accordance with drawings.

f. Check blade alignment.

g. Check each fuse holder for adequate mechanical support of each fuse.

h. Inspect all bus or cable connections for tightness by using calibrated torque wrench. Refer to manufacturer's instructions for proper torque levels.

i. Test all electrical and mechanical interlock systems for proper operation and sequencing.

j. Clean entire switch using approved methods and materials.

k. Check proper phase barrier materials and installation.

l. Lubricate as required.

m. Exercise all active components.

n. Inspect all indicating devices for proper operation.

2. Electrical Tests

a. Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground for one (1) minute.

b. Perform contact-resistance test across each switch blade and fuse holder.

3. Test Values

a. Bolt-torque levels shall be as specified by manufacturer.

b. Minimum insulation resistance shall be in accordance with manufacturer's recommended minimum.

c. Determine contact resistance in microhms. Investigate any values which deviate from adjacent poles or similar switches by more than fifty percent (50%).

C. Circuit Breakers - Low-Voltage - Insulated-Case

1. Visual and Mechanical Inspection

a. Check circuit breaker for proper mounting and compare name-plate data to drawings and specifications.
b. Operate circuit breaker to ensure smooth operation.

c. Inspect case for cracks or other defects.

d. Check tightness of connections using calibrated torque wrench. Refer to manufacturer’s instructions for proper torque levels.

2. Electrical Tests

   a. Perform a contact-resistance test.

   b. Perform and insulation-resistance test at 1000 volts dc from pole to pole and from each pole to ground with breaker closed and across open contacts of each phase.

   c. Determine long-time minimum pickup current by primary current injection where practical.

   d. Perform long-time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately. Record trip time.

   e. Determine short-time pickup and delay by primary current injection, if applicable.

   f. Determine ground-fault pickup and time delay by primary current injection, if applicable.

   g. Determine instantaneous pickup current by primary injection using run-up or pulse method.

3. Test Valves

   a. Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer’s recommendations.

   b. Insulation resistance shall not be less than 100 megohms.

   c. Trip characteristic of breakers shall fall within manufacturer’s published time-current characteristic tolerance band, including adjustment factors.

   d. Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.

D. Circuit Breakers - Low-Voltage – Power

1. Visual and Mechanical Inspection
a. Inspect for physical damage and compare nameplate data with drawings and specifications.

b. Perform mechanical operational test in accordance with manufacturer’s instructions.

c. Check cell fit and element alignment and proper operation of racking interlocks.

d. Check tightness of connections using calibrated torque wrench. Refer to manufacturer’s instructions for proper torque levels.

e. Check arc chutes for damage.

f. Clean entire circuit breaker using approved methods and materials.

g. Lubricate as required.

2. Electrical Tests

a. Perform a contact-resistance test.

b. Perform an insulation-resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.

c. Determine long-time minimum pickup current by primary current injection.

d. Determine long-time delay by primary injection.

e. Determine short-time pickup and delay by primary current injection.

f. Determine ground-fault pickup and delay by primary current injection.

g. Make adjustments for final settings in accordance with breaker setting sheet.

h. Activate auxiliary protective devices, such as ground-fault or under voltage relays, to ensure operation of shunt trip devices. Check the operation of electrically-operated breakers in their cubicle.

i. Check charging mechanism.
3. Test Values
   a. Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%).
   b. Insulation resistance shall not be less than 100 megohms. Investigate values less than 100 megohms.
   c. Trip characteristics of breakers when adjusted to setting sheet parameters shall fall within manufacturer's published time-current tolerance band.

E. Grounding Systems

1. Visual and Mechanical Inspection
   a. Inspect ground system for compliance with drawings and specifications.

2. Electrical Tests (Small Systems)
   a. Perform good-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System." Instrumentation utilized shall be as defined in Section 12 of the above guide and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.

3. Electrical Test (Large Systems)
   a. Perform ground impedance measurements utilizing either the intersecting curves methods of the slope method. (Ref. Nos. 40 and 41 in IEEE Std. 81.)

4. Equipment Grounds
   a. Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode system.

5. Test Values
   a. The main ground electrode system impedance-to-ground should be no greater than five (5) ohms for commercial or industrial systems and one (1) ohm or less for generating stations, transmission stations, and large industrial systems. Equipment
grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

F. Ground-Fault Systems (NEC 230)

1. Visual and Mechanical Inspection
   a. Inspect for physical damage and compliance with drawings and specifications.
   b. Inspect neutral main bonding connection to assure:
      1) Zero-sequence sensing system is grounded.
      2) Ground-strap sensing systems are grounded through sensing device.
      3) Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
      4) Grounded conductor (neutral) is solidly grounded.
   c. Inspect control power transformer to ensure adequate capacity for system.
   d. Manually operate monitor panels (if present) for:
      1) Trip test
      2) No trip test
      3) Non-automatic reset
   e. Record proper operation and test sequence.
   f. Set pickup and time-delay settings in accordance with the settings provided by the owner/user's electrical engineer.

2. Electrical Tests
   a. Measure system neutral insulation resistance to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
   b. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
   c. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
   d. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
e. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.

f. On multiple source, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.

3. Test Parameters

a. System neutral insulation shall be a minimum of one hundred (100) ohms, preferably one (1) megohm or greater.

b. Relay timing shall be in accordance with manufacturer's published time-current characteristics curves in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.

c. Relay pickup value shall be within +/-10% of setting and in no case greater than 1200A.

G. AC Motors

1. Visual and Mechanical Inspection

a. Inspect for physical damage and compare nameplate data with drawings and specifications.

b. Inspect for proper anchorage, mounting, grounding, connection, and lubrication.

c. When applicable, perform special tests such as air gap spacing and pedestal alignment.

d. Check for unusual mechanical or electrical noise or signs of overheating during initial test run.

2. Electrical Test - Induction Motors

a. Perform insulation-resistance tests in accordance with ANSI/IEEE Std. 43.

1) Motor Larger than 200 HP - Test duration shall be ten minutes with resistances tabulated at thirty seconds, one minute, and ten minutes. Dielectric absorption ratio and polarization index will be calculated.

2) Motor 200 HP and Less - Test duration shall be one minute with resistances tabulated at thirty and sixty seconds. The dielectric absorption ratio will be calculated.

b. Perform dc overpotential tests on motors rated at 1000 HP and greater, and 4000 volts and greater in accordance with ANSI/IEEE Std. 95.
c. Perform insulation power-factor or dissipation-factor tests.

d. Perform surge comparison tests.

e. Perform insulation-resistance test on pedestal per manufacturer instructions.

f. Inspect and test surge-protection devices.

g. Test motor starter prior to energizing the motor.

h. Check resistance temperature detector (RTD) circuits for conformance with drawings. Check that metering or relaying devices using the RTDs are of the proper rating.

i. After checking differential relays and differential current transformer circuits perform a system test of the differential scheme by primary injection.

j. Check that the motor space heater circuit is in proper operating condition and in accordance with drawings and specifications.

k. Check all protective devices in accordance with other sections of these specifications.

l. Perform a rotation test to ensure proper shaft direction.

m. Measure running current and evaluate relative to load conditions and nameplate full-load Amperes.

n. Perform vibration tests:

1) Motors Larger then 200 HP - Perform vibration base-line test. Amplitude shall be plotted versus frequency.

2) Motors 200 HP and Less - Perform vibration and amplitude test.

3. Electrical Test - Synchronous Motors

a. Perform tests for induction motors.

b. Perform a voltage-drop test on all salient poles.

c. Perform insulation-resistance tests on the main rotating field winding, the exciter field winding, and the exciter armature winding in accordance with ANSI/IEEE Std. 43.

d. Perform a high-potential test on the excitation system in accordance with ANSI/IEEE Std. 421B.
e. Measure and record resistance of motor-field winding, exciter-stator winding, exciter-rotor winding, and field-discharge resistors. Compare measured values to manufacturer specifications.

f. Perform front-to-back resistance tests on diodes and gating tests of SCRs for field application semiconductors.

g. Prior to initial start, apply rated voltage to the exciter supply and adjust field current to nameplate value.

h. Check that both the field application time-delay relay and the power-factor relay enable time-delay have been tested and set to the motor drive manufacturer’s recommended values.

i. Record stator current, stator voltage, and field current by strip chart recorder for the complete acceleration period including stabilization time for a normally loaded starting condition. From the recording determine the following information:

1) Bus voltage prior to start.

2) Voltage drop at start.

3) Bus voltage at motor full-load.

4) Locked-rotor current.

5) Current after synchronization but before loading.

6) Full-load current.

7) Acceleration time to near synchronous speed.

8) RPM just prior to synchronization.

9) Field application time.

10) Time to reach stable synchronous operation.

j. Plot a V-curve of stator current at approximately fifty percent (50%) load to check proper exciter operation.

k. If range of exciter adjustment and motor loading permit, reduce excitation to cause power factor to fall below the trip value of the power-factor relay. Check relay operation.
4. Test Valves

   a. Perform insulation-resistance tests. Investigate dielectric absorption ratios less than 1.4 and polarization index ratios less than 1.5 for Class A insulation and 2.0 Class B insulation.
   
   b. NOTE: Overpotential, high-potential, and surge-comparison tests shall not be made on motors having valves less than those indicated.
   
   c. Stator winding dc overpotential test voltage shall be in accordance with NEMA publication MG1 paragraph 3.01.L. Tests results are dependent on ambient conditions and evaluation is on a withstand basis. If phase windings can be separately tested, values of leakage current may be compared for similar windings.
   
   d. Salient pole voltage drop should be equal for each pole. Investigate values that differ by more than ten percent (10%).

3.2 Test all power, control, lighting and signal systems for proper operation.

3.3 Obtain services of manufacturer's representatives in thoroughly testing nurse call system, fire alarm system, security system, CCTV system, paging system, and intercom system.

3.4 Test every receptacle to be sure power is available at it, and for proper polarity and ground connection.

3.5 Take voltage readings on various portions of the distribution system if so directed by the Engineer, and, if deemed necessary by the Engineer, reset taps in transformers.

3.6 Insure that building power, lighting, motor and appliance loads are balanced between phases of service entrances, distribution feeders and/or transformers as closely as possible. Special care shall be taken during load balance to assure that reverse rotation of motors does not occur.

3.7 Assist Contractors for other work in testing their equipment if required to do so. (e.g., after motors are bumped for rotation, reverse leads if necessary to reverse rotation.)

3.8 If deficiencies are found in any of the testing, correct same and retest. Repeat process until all systems are functioning properly.

END OF SECTION
SECTION 26 05 19
BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building wire and cable.
B. Wiring connectors and connections.

1.2 RELATED SECTIONS

A. Section 26 00 10 – Basic Electrical Requirements
B. Section 26 05 33.10 – Raceway for Electrical Systems.
C. Section 26 05 33.20 – Boxes for Electrical Systems.
D. Section 26 05 53 – Identification for Electrical Systems

1.3 REFERENCES

B. NECA (National Electrical Contractor’s Association) - NECA 1-2000 “Standard Practices For Good Workmanship in Electrical Contracting.”

1.4 PROJECT CONDITIONS

A. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
B. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.5 COORDINATION

A. Determine required separation between cable and other work.
B. Determine cable routing to avoid interference with other work.

PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

A. All wire for light, power, and control systems shall be single copper conductor, stranded, with 600 volt type THHN, THWN-2, or XHHW-2 insulation unless otherwise noted on drawings or specified herein.
B. Use only type XHHW-2 in computer rooms and imaging rooms.
C. Cords for makeup connections shall contain an identified ground conductor and shall be composed of 600 volt heat resistant, rubber insulated, portable cable.
with neoprene jacket, type SO or W, with extra flexible stranded copper conductors.

D. Branch circuit wiring in fluorescent fixtures, within 6 inches of boiler breeching, and in other high temperature locations, shall be rated 90 deg. C.

E. For auxiliary systems such as fire alarm, process controls, etc., use cable specified under the appropriate heading or cable recommended by system manufacturer.

2.2 ARMORED CABLE

A. Manufacturer: AFC Cable Systems, Type Green HCF-90, or approved equal, with green grounding conductor.

B. Description: ANSI/NFPA 70, Type AC.

C. Conductor: Copper.

D. Insulation Voltage Rating: 600 volts.

E. Insulation Temperature Rating: 90 degrees C.

F. Insulation Type: THHN.

G. Outer covering: Galvanized steel

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire has been completed.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

A. All wiring shall be installed in conduit unless otherwise indicated on drawings.

B. Use wiring methods indicated on Drawings.

C. Install products in accordance with manufacturer’s instructions.

D. Cables installed in vertical raceways shall be supported in accordance with ART 300-19 of the National Electrical Code. Supports shall be Kellems Heavy duty wire mesh type conduit riser support grips.
E. Conductors for power and lighting circuits shall not be smaller than # 12 AWG.
F. Conductors for control circuits shall not be smaller than # 14 AWG.
G. All wires of any one circuit shall be run in the same conduit. No more than three current carrying conductors (exclusive of ground conductors and neutral conductors) shall be run in the same conduit, unless otherwise noted.
H. Conductors for 120 volt, 20 Ampere branch circuits longer than 100 feet shall be # 10 AWG.
I. Conductors for 277 volt, 20 Ampere, branch circuits longer than 200 feet shall be # 10 AWG.
J. Pull all conductors into raceway at the same time.
K. Use suitable wire pulling lubricant for building wire # 4 AWG and larger.
L. Neatly train and lace wiring inside boxes, equipment, and panelboards using Thomas and Betts “Ty-Rap” or approved equal, cable ties.
M. Clean conductor surfaces before installing lugs and connectors.
N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
O. Use split bolt connectors or long barrel compression lugs installed with a minimum of two crimps per termination for copper conductor splices and taps, # 8 AWG and larger. Tape uninsulated conductors, connectors and splices with electrical tape to 150 percent of insulation rating of conductor or provide UL listed heat shrink tubing insulating system, Raychem WCSM or 3M 600 Volt “Cold Shrink” tubing insulating system.
P. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, # 10 AWG and smaller. Fixed spring connectors and self-stripping tap connectors shall not be used.

3.4 WIRING METHODS
A. Concealed Dry Interior Locations: Use building wire, Type THHN/THWN or XHHW-2 insulation, in raceway.
B. Exposed Dry Interior Locations: Use building wire, Type THHN/THWN-2 or XHHW-2 insulation, in raceway.
C. Above Accessible Ceilings: Use building wire, Type THHN/THWN-2 or XHHW-2 insulation, in raceway.
D. Wet or Damp Interior Locations: Use only building wire, Type XHHW-2 insulation, in raceway.
E. Exterior Locations: Use only building wire, Type XHHW-2 insulation, in raceway.
F. Underground Installations: Use only building wire, Type XHHW-2 insulation, in raceway.
G. Use wiring methods indicated on Drawings.
H. Computer Room Locations: Use only building wire, Type XHHW-2 insulation, in raceway.
I. Essential Electrical Systems for Hospitals: circuits shall be installed in nonflexible metal raceways in accordance with NEC Article 517-30(C)(3).
J. Type AC cable shall be restricted to maximum length of six feet for final connection to light fixtures.
K. Type AC cable may be used for normal branch circuit drops to wiring devices. Overall cable length shall not exceed 25 feet.

3.5 INTERFACE WITH OTHER PRODUCTS
A. Identify wire and cable under provisions of Section 26 05 53.
B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.6 FIELD QUALITY CONTROL
3.7 Inspect wire for physical damage and proper connection.
3.8 Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
3.9 Verify continuity of each branch circuit conductor.

END OF SECTION
SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION 26 05 26
   A. Grounding electrode(s) and conductors.
   B. Equipment grounding conductors.
   C. Bonding.

1.2 RELATED SECTIONS
   A. Section 26 00 10 – Basic Electrical Requirements

1.3 REFERENCES

1.4 GROUNDING ELECTRODE SYSTEM
   A. Metal underground water pipe
   B. Metal frame of the building
   C. Ground rods

1.5 PERFORMANCE REQUIREMENTS
   A. Grounding System Resistance: 5 ohms.

PART 2 - PRODUCTS

2.1 GROUND RODS
   A. Copper clad steel, ¾" x 10', UL listed.

2.2 MECHANICAL CONNECTORS
   A. Material: Bronze, UL listed.

2.3 EXOTHERMIC CONNECTIONS
   A. Manufacturers:
      1. Thermoweld, Cadweld, or approved equal.
2.4 WIRE
   A. Material: Bare stranded copper.
   B. Grounding Electrode Conductor: # 4/0 AWG.
   C. Equipment grounding conductor: Sized per NEC table 250-95.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify that final backfill and compaction has been completed before installing ground rods.

3.2 INSTALLATION
   A. Install Products in accordance with manufacturer's instructions.
   B. Install ground rods at locations indicated. Install additional ground rods as required to achieve specified resistance to ground.
   C. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing. Bond steel together.
   D. Bond grounding electrode system to incoming water lines(s).
   E. Provide bonding to meet Regulatory Requirements and the NEC.
   F. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Bond ground wires to all junction boxes, to ground busses of all equipment provided with same, to motor frames, and non-current carrying metal parts of all other equipment to which electrical connections are made.
   G. Ground all receptacles by bonding ground wire to outlet box and then extending a jumper to the device grounding pole. Do not rely on self-grounding type mounting screws alone to establish ground.
   H. Bond all conduit using grounding bushings or other approved means.
   I. In each electric closet or grouping of panels, bond all panelboard ground busses together using a green insulated copper conductor of # 10 AWG minimum size.
   J. Connect ground bars in busways entering switchgear assemblies to switchgear ground bus. Bond all metallic conduits to switchgear ground bus.
   K. Electrical Contractor shall provide grounding electrode conductors and connections between all transformer secondaries and the building grounding...
electrode system as required by NEC 250-5(d). Conductors shall be sized and installed in accordance with NEC 250-26.

3.3 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer’s recommendations using the fall of potential method. Record and report results to the Engineer.

3.4 GROUND RODS (2.1 ALTERNATE INFORMATION)

A. Ground rods shall be LEC, Inc, “Chem-Rod” type CR-10-D, 10 ft. long x 2 inches dia. with EZ access inspection floor caps and filled with mineral salts blended for dry soil conditions. Install Chem-Rods in 6 inches dia. holes drilled in earth or rock.

B. Place the fiberglass access well enclosures furnished with the Chem-Rods in the 6 in. dia. holes and fill space between Chem-Rods and enclosure with LEC, Inc. GAF (Grounding Augmentation Fill).

C. Install access well covers in floor slab for inspection and recharging Chem-Rods with mineral salts.

D. Install Chem-Rods at locations in floor that will permit future access for inspection.

E. Each Chem-Rod shall have 2 ft. long # 4/0 CU. pigtail for connection to # 4/0 ground ring.

F. Complete installation shall be in accordance with manufacturer’s written instructions and recommendations.

END OF SECTION
SECTION 26 05 29
ELECTRICAL HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Conduit and equipment supports.
B. Anchors and fasteners.

1.2 REFERENCE SECTIONS
A. Section 26 00 10 – Basic Electrical Requirements.

1.3 REFERENCES

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS
A. Materials and Finishes: Provide adequate corrosion resistance.
B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
C. Anchors and Fasteners:
   1. Concrete Structural Elements: Use expansion anchors.
   2. Steel Structural Elements: Use beam clamps.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Provide anchors, fasteners, and supports in accordance with NECA 1-2000.
C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Do not use spring steel clips and clamps.

E. Obtain permission from Construction Manager before using powder-actuated anchors.

F. Do not drill or cut structural members.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

END OF SECTION
SECTION 26 05 33.10
RACEWAY FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Metal conduit.
B. Flexible metal conduit.
C. Liquid-tight flexible metal conduit.
D. Electrical metallic tubing.
E. Nonmetallic conduit.
F. Fittings and conduit bodies.

1.2 RELATED SECTIONS

A. Section 01 73 29 - Cutting and Patching.
B. Section 26 00 10 – Basic Electrical Requirements
C. Section 26 05 33.20 – Boxes for Electrical Systems.
D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
E. Section 26 05 29 - Hangers and Supports for Electrical Systems.
F. Section 26 05 53 - Identification for Electrical Systems.

1.3 REFERENCES

B. ANSI C80.3-1994 - Electrical Metallic Tubing, Zinc Coated (EMT).
C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
D. ANSI/NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit (ENT & RNC).
E. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 DESIGN REQUIREMENTS
A. Conduit Size: ANSI/NFPA 70.
B. Minimum Size: ¾” Trade size unless otherwise specified or noted.

1.5 PROJECT CONDITIONS
A. Verify that field measurements are as shown on Drawings.
B. Verify routing and termination locations of conduit prior to rough-in.
C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

1.6 CONDUIT REQUIREMENTS
A. Underground Installations:
   1. More than Five Feet from Foundation Wall: Use Schedule 40 nonmetallic conduit.
   2. Within Five Feet from Foundation Wall: Use galvanized rigid steel conduit.
   3. Under Slab on Grade: Use Schedule 40 nonmetallic conduit with rigid steel elbows up through slab.
B. Installations in concrete or masonry walls: Use rigid steel conduit.
C. Outdoor Locations, Above Grade: Use rigid steel conduit.
D. Wet and Damp Locations: Use rigid steel conduit.
E. Dry Locations:
   2. Exposed: Use electrical metallic tubing.
F. Feeders over 600 volts: Use rigid steel conduit.
G. Conduit for fire pump room: Use rigid steel conduit.
H. Connections to motors, transformers and other equipment subject to vibration: Use Liquid-tight flexible metal conduit.
PART 2 - PRODUCTS

2.1 METAL CONDUIT (RMC)
   A. Rigid Steel Conduit: ANSI C80.1.
   B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit.

2.2 FLEXIBLE METAL CONDUIT (FMC)
   A. Description: Interlocked steel construction.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFNC)
   A. Description: Interlocked steel construction with PVC jacket.

2.4 ELECTRICAL METALLIC TUBING (EMT)
   A. Description: ANSI C80.3; galvanized tubing.
   B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel or malleable iron set screw type.

2.5 NONMETALLIC CONDUIT (ENT)
   A. Description: NEMA TC 2; Schedule 40 PVC.
   B. Fittings and Conduit Bodies: NEMA TC 3.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install conduit in accordance with NECA (National Electrical Contractor's Association) - NECA 1-2000 "Standard Practices For Good Workmanship in Electrical Contracting."
   B. Install nonmetallic conduit in accordance with manufacturer's instructions.
   C. Conduit shall not block access to equipment.
   D. Arrange supports to prevent misalignment during wiring installation.
   E. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and/or split hangers.
F. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

G. Fasten conduit supports to building structure and surfaces under provisions of Section 26 05 29.

H. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

I. Do not attach conduit to ceiling support wires.

J. Arrange conduit to maintain headroom and present neat appearance.

K. Route exposed conduit parallel and perpendicular to walls.

L. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

M. Route conduit under slab from point-to-point.

N. Maintain adequate clearance between conduit and piping.

O. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

P. Maintain at least 6 feet clearance between conduit and lightning grounding conductors.

Q. Cut conduit square using saw or pipe cutter. De-burr cut ends.

R. Bring conduit to shoulder of fittings. Fasten securely.

S. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

T. Where conduits enter boxes or cabinets, install double locknuts and insulated metallic bushings. Use "Liquatite" insulated fittings to terminate all flexible conduit.

U. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Conduit bends shall be of long radius and shall be made using benders approved by the conduit manufacturer for the purpose. Bends shall not cause kinking, cross sectional deformation or reduction of inside diameter.

V. Contractor shall install pull boxes where required to meet NEC requirements for maximum number of bends in a conduit run.

W. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
X. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints. Maintain ground continuity across fittings.

Y. Provide suitable pull string in each empty conduit except sleeves and nipples.

Z. Use suitable caps to protect installed conduit against entrance of dirt and moisture until wires are pulled.

AA. Ground and bond conduit under provisions of Section 26 05 26.

BB. Identify conduit under provisions of Section 26 05 53.

CC. Underground conduits that run beneath walkways and driveways/roadways shall be concrete encased. Provide minimum of 3 inch cover at bottom, top and sides of conduit. Use mineral pigment to color the concrete red.

DD. Provide a 4 inch high curb around conduits where they pass through floors.

EE. Connect power to motors with a 6 foot maximum length of liquid-tight flexible metal conduit to provide for flexibility in adjusting the motor and for vibration isolation. Support the source end of the flexible conduit to prevent movement.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods defined elsewhere in the Contract Documents.
SECTION 26 05 33.20
BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Wall and ceiling outlet boxes.
B. Pull and junction boxes.

1.2 RELATED SECTIONS
A. Section 26 00 10 – Basic Electrical Requirements
B. Section 26 05 33.10 – Raceway for Electrical Systems.
C. Section 26 27 16 – Electrical Cabinets and Enclosures.

1.3 REFERENCES
A. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
B. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
C. NEMA OS 2 (National Electrical Manufacturers Association) - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 CLOSEOUT SUBMITTALS
A. Submit under provisions of Section 26 00 10.
B. Accurately record actual locations and mounting heights of outlet, pull, and junction boxes.

1.5 PROJECT CONDITIONS
A. Verify locations of outlets prior to rough-in.
B. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Refer to dimensioned architectural drawings and elevations and casework vendor’s drawings. Install at location required for box to serve intended purpose or as directed in field. Refer conflicts to Engineer prior to installation.
C. Furnish access panels where required in walls and ceilings, for access to boxes, controls, equipment items, etc., to the mason, plasterer, or acoustical ceiling contractor for installation. This contractor shall pay for their installation. Obtain Construction Manager/Architect’s approval on location, size, and type of each panel before installation. Ceiling access panels shall be 18 by 24 inch minimum. Access panels shall be Inland Steel products "Milcor," or approved equal, style "A", "K", or "M" as appropriate. Panels shall have hinged doors with cam locking device and prime coat paint finish.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized steel.

B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include ½ inch (13 mm) male fixture studs where required.

C. Cast Boxes: NEMA FB 1, Type FD, cast ferroloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

D. Non-metallic outlet boxes: NEMA OS 2, molded PVC. Provide gasketed cover by box manufacturer.

2.2 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box.
   1. Material: Galvanized cast iron.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

C. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting.
   1. Material: Galvanized cast iron.
   2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
   3. Cover Legend: ELECTRIC.
PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if raceway servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

B. Ensure access to existing raceway and boxes and other installations which remain active and require access. Modify installation or provide access panel as appropriate.

C. Extend existing raceway boxes and other installations using materials and methods as specified.

D. Clean and repair existing raceway and boxes which remain or are to be reinstalled.

3.2 INSTALLATION

A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

D. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

E. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods approved by Architect.

F. Outlets adjacent to one another in any room or corridor shall be in horizontal or vertical alignment, unless otherwise shown.

G. Use flush mounting outlet boxes in finished areas.

H. Do not install flush mounting boxes back-to-back in walls. Provide a minimum 6 inch horizontal separation. Provide a minimum 24 inches horizontal separation in acoustic rated walls.

I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

J. Use stamped steel bridges to fasten flush mounting outlet box between studs.
K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Use adjustable steel channel fasteners for hung ceiling outlet box.

M. Do not fasten boxes to ceiling support wires.

N. Support boxes independently of conduit.

O. Use gang box where more than one device is mounted together. Do not use sectional box.

P. Use gang box with plaster ring for single device outlets.

Q. Use cast outlet box in exterior locations and wet locations.

R. Large Pull Boxes: Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.
   1. Interior Dry Locations: Use hinged enclosure under provisions of Section 26 27 16.
   2. Other Locations: Use surface-mounted cast metal box.

S. Determine the exact location of ceiling lighting fixtures from the architectural reflected ceiling plans.

T. Where fixtures occur in acoustic tile ceilings, they shall be centered in tile, take the place of tile, or be centered at intersection of four tiles, as indicated on the drawings.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

3.4 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closure in unused box opening.

END OF SECTION
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL
1.1. SECTION INCLUDES
   A. Nameplates and labels.
   B. Wire and cable markers.
   C. Conduit markers

1.2. REFERENCES

PART 2 - PRODUCTS
2.1. NAMEPLATES AND LABELS
   A. Nameplates: Engraved two-layer laminated plastic, black letters on white background. Edges shall be beveled.
   B. Locations:
      1. Each electrical distribution and control equipment enclosure.
   C. Letter Size:
      1. Use 3/16 inch letters for identifying individual equipment and loads.
      2. Use 1/4 inch letters for identifying grouped equipment and loads.

2.2. WIRE MARKERS
   A. Description: Tape type wire markers.
   B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.
   C. Legend:
      1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

2.3. CONDUIT MARKERS
   A. Location: Paint color bands on each conduit longer than 6 feet.
   B. Spacing: 20 feet on center.
   C. Color:
1. Power System: No marking.
2. Fire Alarm: Red
3. Computer/Data: Orange
4. Telephone: Green
5. Security: White
6. CCTV/MATV: Blue

PART 3 - EXECUTION

3.1. PREPARATION
   A. Clean surfaces before installing nameplates.
   B. Degrease and clean surfaces before painting color bands.

3.2. APPLICATION
   A. Install nameplate parallel to equipment lines.
   B. Secure nameplate to equipment front using stainless steel self-tapping sheet metal screws and adhesive. Use of adhesive only will not be acceptable.
   C. Paint colored band on each conduit longer than 6 feet.
   D. Paint bands 20 feet on center.

END OF SECTION
SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall switches.
B. Wall dimmers.
C. Receptacles.
D. Device plates and decorative box covers.
E. Poke thru fittings.

1.2 RELATED SECTIONS

A. Section 26 00 10 – Basic Electrical Requirements.
B. Section 26 05 33.20 – Boxes for Electrical Systems.

1.3 REFERENCES

A. NEMA WD 1 - General Purpose Wiring Devices.
B. NEMA WD 6 - Wiring Device Configurations.

1.4 SUBMITTALS

A. Submit under provisions of Sections 26 00 10.
B. Product Data: Provide manufacturer’s catalog information showing ratings, dimensions, colors and configurations.

1.5 CLOSEOUT SUBMITTALS

A. Submit under provisions of Sections 26 00 10.
B. Indicate the locations of all wiring devices on the drawings.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:

1. Hubbell
2. Leviton
3. Pass & Seymour
4. General Electric
5. Arrow Hart
B. Description: NEMA WD 1, heavy-duty, AC only general use snap switch, single pole, double pole, momentary contact, 3-way, 4-way or lighted as indicated on the drawings.

C. Device Body and Handle: Ivory plastic with toggle handle.

D. Indicator Light: Lighted handle type switch; red color handle, lighted when switch is on 208-277 Volts.

E. Locator Light: Lighted handle type switch; red color handle, lighted when switch is off, 208-277 Volts.

F. Voltage Rating: 120-277 Volts, AC.

G. Current Rating: 20 Amperes.

2.2 WALL DIMMERS

A. Manufacturers

1. Lutron “Nova T-Star”.

2. Description: NEMA WD 1, Type II semiconductor dimmer for incandescent lamps.

3. Device Body and Handle: Ivory plastic with linear slide.


5. Power Rating: Match load shown on the drawings; 600 watts maximum.

2.3 RECEPTACLES

A. Manufacturers:

1. Hubbell
2. Leviton
3. Pass & Seymour
4. General Electric
5. Arrow Hart

B. All duplex receptacles shall be Specification Grade (HBL5362 for 20 Amperes).

C. Duplex receptacles connected to a 20 Ampere circuit which supplies only one receptacle shall be 20A, 125V, with back and side wiring and nylon or Lexan face.

D. Duplex receptacles connected to a 20 Ampere circuit which supplies two or more receptacles shall be 15A, 125V, with back and side wiring and nylon or Lexan face.
E. Normal service receptacles shall be ivory color and emergency service receptacles shall be red.

F. Receptacles identified on drawings as "GFI" shall be ground fault interrupter type, duplex, 125V, 15 or 20 Amperes as required by number of outlets on circuit with provisions for feed through. Refer to Sections 2.3.C and 2.3.D.

G. Single receptacles shall be of same series as specified for duplex receptacles.

H. Heavy duty receptacles, 250V and/or 30 Ampere and above, shall be straight-blade type, of voltage and ampere ratings indicated on drawings.

I. Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked “Suitable for Wet Locations While In Use”. Provide gasket between the hinged cover and mounting plate/base and between the enclosure and the mounting surface to assure a proper seal. Cover/enclosure shall be TayMac or approved equal, model MM400C for exterior locations and model 10310 or 20310 for interior locations.

J. All wall switches and receptacles shall be by the same manufacturer unless approved by the Engineer.

2.4 COVER PLATES

A. Cover plates for flush mounted devices shall be impact-resistant nylon. Cover plates for normal service receptacles shall be ivory color and for emergency service receptacles shall be red. All switch cover plates shall be ivory color. Two or more devices indicated side by side shall have a common cover plate. Cover plates for emergency outlets shall be labeled to indicate panelboard and circuit number to which outlet is connected.

B. Surface mounted devices shall have cadmium plated steel cover plates.

2.5 POKE THRU FITTINGS

A. Poke thru fittings shall be Wiremold RC3 series or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions.

B. Verify outlet boxes are installed at proper height. Refer to architectural elevations and casework drawings. Refer conflicts to Engineer, prior to installation.

C. Verify wall openings are neatly cut and will be completely covered by wall plates.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Receptacles in multi-gang installations shall be installed with pigtails attached for connecting the receptacles to the branch circuit wiring. Jumper wires shall not be used between receptacles.
B. Install products in accordance with manufacturer’s instructions.
C. Install devices plumb and level.
D. Install switches with OFF position down.
E. Install receptacles with grounding pole on bottom.
F. Install wall dimmers to achieve full rating specified and indicated on the drawings after derating for ganging as instructed by manufacturer.
G. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
H. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
I. Cover plates for flush boxes or devices shall not be used as tension or rigidity agents to secure the outlet. Boxes must be flush with finish walls and this must be accomplished by means of proper extension rings where necessary.
J. All receptacles located in bathrooms, outside, or within six feet of a sink shall be GFI type whether or not indicated on drawings.
K. Install devices in weatherproof cast aluminum boxes, UL listed for wet/damp locations, at the locations noted on the drawing.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 26 05 33.20 to obtain mounting heights specified and indicated on drawings.
B. Install wall switch(es) 48 inches above finished floor unless otherwise noted.
C. Install convenience receptacle(s) 18 inches above finished floor unless otherwise noted.
D. Install convenience receptacle(s) 6 inches above backsplash of counter unless otherwise noted.

E. Install telephone/data jack for desk use 18 inches above finished floor.

F. Install telephone jack for wall telephone 48 inches above finished floor.

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFI receptacle device for proper operation.

F. Verify that each telephone/data jack is properly connected and circuit is operational.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION
SECTION 26 28 16.20
ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Fusible switches.
B. Non-fusible switches.
C. Fuses.

1.2 RELATED SECTIONS
A. Section 26 00 10 – Basic Electrical Requirements.
B. Section 26 05 29 – Hangers and Supports for Electrical Systems.
C. Section 26 05 53 – Identification for Electrical Systems.

1.3 REFERENCES
A. NEMA KS 1 - Enclosed Switches.
B. UL 198E - Class R Fuses.
C. NFPA 70 - National Electrical Code.
D. NECA (National Electrical Contractor’s Association) - NECA 1-2000 “Standard Practices For Good Workmanship in Electrical Contracting.”

1.4 SUBMITTALS
A. Submit under provisions of Sections 26 00 10.
B. Product Data: Provide switch ratings and enclosure dimensions.

1.5 CLOSEOUT SUBMITTALS
A. Submit per Sections 26 00 10.
B. Project Record Documents: Record actual locations, configurations, and ratings of enclosed switches on the drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Square D.
B. Cutler-Hammer
2.2 ENCLOSED SWITCHES

A. Fusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate Class R fuses. Switch shall be equipped with an interlock defeat feature to permit access to the switch with the switch in the closed position.

B. Non-fusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Switch shall be equipped with an interlock defeat feature to permit access to the switch with the switch in the closed position.

C. Enclosures: NEMA KS 1.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: Type 3R.

2.3 FUSES

A. Manufacturers:
   1. Bussman
   2. Littelfuse
   3. Gould-Shawmut

B. Description: Dual element, current limiting, time delay, one-time fuse, 600 Volt, UL 198E, Class RK 1.

C. Interrupting Rating: 200,000 RMS Amperes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches where indicated on the drawings.

B. Install fuses in fusible disconnect switches.

C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

D. Provide plastic laminate nameplate on cover to describe the switched load. Refer to Section 26 05 53 and the drawings for nameplate requirements.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

1.2 Section includes manual and magnetic motor controllers in individual enclosures.

1.3 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   2. NEMA FU 1 - Low Voltage Cartridge Fuses.
   3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
   4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
   5. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
   6. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. International Electrical Testing Association:

1.4 SUBMITTALS

A. Section 26 00 10 – Basic Electrical Requirements: Submittal procedures.
   1. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
   2. Test Reports: Indicate field test and inspection procedures and test results.

1.5 CLOSEOUT SUBMITTALS

A. Specification section titled “Execution and Closeout Requirements:” Closeout procedures.
B. Project Record Documents: Record actual locations and ratings of enclosed controllers.

C. Operation and Maintenance Data: Submit Replacement parts list for controllers.

1.6 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years [documented] experience.

PART 2 - PRODUCTS

2.1 MANUAL MOTOR CONTROLLER
A. Manufacturers:
   1. Square D
   2. Eaton (Cutler Hammer)
   3. Allen-Bradley

B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, 2 NO & 2 NC auxiliary contacts, and push button operator.

C. Enclosure: NEMA ICS 6, Type to meet conditions of installation.

2.2 FRACTIONAL-HORSEPOWER MANUAL CONTROLLER
A. Manufacturers:
   1. Square D
   2. Eaton (Cutler Hammer)
   3. Allen-Bradley

B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and toggle operator.

C. Enclosure: NEMA ICS 6, Type to meet conditions of installation.

2.3 FULL-VOLTAGE NON-REVERSING CONTROLLERS
A. Manufacturers:
   1. Square D
   2. Eaton (Cutler Hammer)
   3. Allen-Bradley

B. Product Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
1. Control Voltage: 120 Volts, 60 Hertz.
2. Overload Relay: NEMA ICS 2; bimetal.

C. Product Features:

1. Auxiliary Contacts: NEMA ICS 2, two each NO and NC contacts in addition to seal-in contact.
2. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty, oiltight type.
4. Pushbuttons: Shrouded type.
5. Indicating Lights: LED type.
8. Combination Controllers: Combine motor controllers with disconnecting means in common enclosure, using thermal magnetic circuit breaker conforming to NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole.
9. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
10. Interior Dry Locations: Type 1.
11. Exterior Locations: Type 3R.

PART 3 - EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned enclosed motor controllers.

B. Maintain access to existing enclosed motor controllers and other installations to remain active and to require access. Modify installation or provide access panel.

C. Clean and repair existing enclosed motor controllers to remain or to be reinstalled.

3.2 INSTALLATION

A. Install enclosed controllers plumb. Provide supports in accordance with Section 26 05 29.
B. Height: 5 feet to operating handle.

C. Select and install overload heater elements in motor controllers to match installed motor characteristics.

D. Install engraved plastic nameplates. Refer to Section 26 05 53 for product requirements and location.

E. Neatly type label and place inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.3 FIELD QUALITY CONTROL

A. Specification sections titled “Quality Requirements” and “Execution and Closeout Requirements”: Field inspecting, testing, adjusting, and balancing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION
SECTION 26 40 60
MINOR ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Electrical demolition.

1.2 REFERENCES

1.3 GENERAL
A. The other Contract Documents complement the requirements of this Section. The General Requirements apply to the work of this Section.
B. Provide labor and material necessary to complete the demolition of the Electrical Work as specified herein and indicated on the accompanying drawings.
C. Examine not only the drawings and specifications for this branch of work, but plans and specifications of the other branches of work and visit the site to become acquainted with existing conditions. Submitting a bid signifies that conditions which have a bearing in any way on the removal of work herein specified are known and included in bid.
D. Contractor shall obtain, at his own expense, all necessary permits and pay all charges for inspection of his work.
E. Drawings are original building documents and do not necessarily depict actual quantities and job conditions. Contractor shall visit site to determine actual scope of work.

1.4 SCOPE OF WORK
A. Disconnect and remove electrical distribution equipment, light fixtures, wiring devices, boxes, conduit, and wire.
B. Disconnect and remove wire and conduit from mechanical equipment which is to be removed by others. Coordinate this work with other trade contractors
C. Remove and salvage designated items.
D. Provide temporary electric.
E. Dispose of demolished items.
F. Electrical Contractor shall plug, seal, and firestop all penetrations of fire rated and acoustically sensitive walls and floors due to abandoned openings created by electrical demolition.

1.5 ASBESTOS PROTECTION

A. The Owner has retained an asbestos abatement contractor to remove materials containing asbestos which would be affected by this project. Contractor shall make his employees and subcontractors aware of this situation, and shall take appropriate precautions.

B. If asbestos is encountered during demolition, Contractor shall immediately stop work and notify Architect so Owner can arrange to have it removed by others.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition work is based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.

D. Beginning of demolition means installer accepts existing conditions.

E. Before disconnecting any electrical risers, feeders, or branch circuits, verify that they do not serve any other areas.

3.2 PREPARATION

A. Coordinate utility service outages with Owner, Construction Manager, and Utility Company.

B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits use personnel experienced in such operations.

C. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and
connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

D. Existing Emergency System: Maintain existing system in service until new system is complete and ready for service. Notify the Owner, Engineer, and Construction Manager at least 72 hours before switchover.

E. Disconnect electrical systems in walls, floors and ceilings scheduled for removal.

F. Provide temporary wiring and connections to maintain lighting and power during demolition.

G. Provide temporary barricades and other necessary protection to protect others from demolition work. This Contractor shall keep others informed of electric equipment which is energized to prevent injury due to electric shock.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of this Section.

B. Perform electric demolition work in an orderly and careful manner. Disconnect and remove all electrical distribution equipment, light fixtures, wiring devices, boxes, fittings, hangers, supports, conduit and wire unless otherwise noted.

C. Remove debris, rubbish, and other materials resulting from demolition work, from building and site on a daily basis.

3.4 SALVAGE EQUIPMENT

A. Where items are tagged by Owner, items will remain property of Owner and Contractor shall carefully remove items and store in area on site where designated by Owner.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

F. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

G. Extend existing installations using materials and methods as specified.
3.5 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION