University of Maryland Baltimore County
Renovations to Patapsco Hall
UMBC CS2003-1736-F

Specifications

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JPA Commission No. 4938-01 (41)

James Posey Associates, Inc.
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SECTION 01100

SUMMARY OF WORK

PART 1 GENERAL

1.01 ENGINEER

A. Throughout the Bidding and Contract Documents, General Requirements (Division 1), and technical sections, all references to the Engineer or to the Architect shall mean James Posey Associates, Inc.

1.11 SECTION INCLUDES

A. Brief project description.
B. Owner furnished products.
C. Contractor use of site and premises.

1.21 DEFINITIONS

A. Project correction period: A period after Substantial Completion of the work during which the Contractor shall correct every part of the work found to be not in accordance with the requirements of the contract documents, promptly after receipt of written notice.

1.22 BRIEF PROJECT DESCRIPTION

A. All work for the following (except demolition and electrical work performed under a separate contract).
B. Building type: Dormitory
C. Major materials and systems: Vertical, high-rise fan-coil units; tertiary piping and pumping for chilled water and heating water systems originating in a local SCUB.
D. Special features: New direct digital controls and domestic hot water generation.
E. Size, sq ft: 80,000

1.24 OWNER FURNISHED PRODUCTS

A. Products furnished to the site and paid for by Owner:
   1. Fan-coil units, air-handling units, and other equipment noted on the drawings.

B. Owner's responsibilities:
   1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
   2. Turn over units, in storage offsite, to contractor.
   3. Inspect products jointly with Contractor.
4. Submit claims for transportation damage and replace damaged, defective, or deficient items prior to receipt by contractor.

5. Arrange for manufacturers' warranties, inspections and service.

C. Contractor's responsibilities:

1. Review Owner reviewed shop drawings, product data, and samples.

2. Receive and unload products in storage, inspect, for completeness or damage, jointly with Owner.

3. Handle, transport to project site, store, install and finish products.

4. Repair or replace items damaged after receipt.

1.25 CONTRACTOR USE OF SITE AND PREMISES

A. Limit use of site and premises to allow:

1. Work by others.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

END OF SECTION
SECTION 01120
ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Coordinate work of trades and schedule elements of alterations and renovation work by procedures and methods to expedite completion of the work.

B. In addition to demolition specified in other sections and that specifically shown, cut, move or remove items as necessary to provide access or to allow alterations and new work to proceed. Include such items as:

1. Repair or removal of hazardous or unsanitary conditions.

2. Removal of abandoned items and items serving no useful purpose, such as abandoned piping, conduit and wiring.

3. Removal of unsuitable or extraneous materials not marked for salvage, such as abandoned furnishings and equipment, and debris such as rotted wood, rusted metals and deteriorated concrete.

4. Cleaning of surfaces and removal of surface finishes as needed to install new work and finishes.

C. Patch, repair and refinish existing items to remain, to the specified condition for each material, with a workmanlike transition to adjacent new items of construction.

1.14 RELATED SECTIONS

A. Cutting and patching: Section 01731.

B. Cleaning during construction: Section 01770.

1.40 ALTERATIONS, CUTTING AND PROTECTION

A. Assign the work of moving, removal, cutting and patching, to trades qualified to perform the work in a manner to cause least damage to each type of work, and provide means of returning surfaces to appearance of new work.

B. Perform cutting and removal work to remove minimum necessary, and in a manner to avoid damage to adjacent work.

1. Cut finish surfaces such as masonry, tile, plaster or metals, by methods to terminate surfaces in a straight line at a natural point of division.

C. Perform cutting and patching as specified in Section 01731.

D. Protect existing finishes, equipment, and adjacent work which is scheduled to remain, from damage.

1. Protect existing and new work from weather and extremes of temperature.

a. Maintain existing interior work above 60 degrees F.
b. Provide weather protection, waterproofing, heat and humidity control as needed to prevent damage to remaining existing work and to new work.

E. Provide temporary enclosures to separate work areas from existing building and from areas occupied by Owner, and to provide weather protection.

1.70 SEQUENCE AND SCHEDULES

A. Schedule work in the sequences and within times specified in Section 01100.

B. Submit separate detailed sub-schedule for alterations work, coordinated with the Construction Schedules. Show:
   1. Each stage of work, and dates of occupancy of areas.
   2. Date of Substantial Completion for each area of alterations work, as appropriate.
   3. Trades and subcontractors employed in each stage.

PART 2 - PRODUCTS

2.12 PRODUCTS FOR PATCHING, EXTENDING AND MATCHING

A. Provide same products or types of construction as that in existing structure, as needed to patch, extend or match existing work.
   1. Generally Contract Documents will not define products or standards of workmanship present in existing construction; determine products by inspection and any necessary testing and workmanship by use of the existing as a sample of comparison.

B. Presence of a product, finish, or type of construction, requires that patching, extending or matching shall be performed as necessary to make Work complete and consistent to identical standards of quality.

PART 3 - EXECUTION

3.21 SPECIAL TECHNIQUES

A. Patch and extend existing work using skilled mechanics who are capable of matching existing quality of workmanship. Quality of patches or extended work shall be not less than that specified for new work.

3.22 ADJUSTMENTS

A. Where partitions are removed, patch floors, walls, and ceilings, with finish materials to match existing.
   1. Where removal of partitions results in adjacent spaces becoming one, rework walls, floors and ceiling to provide smooth planes without breaks, steps, or bulkheads.
   2. Where planes change, request instructions from Engineer as to method of making transition.

B. Trim and refinish existing doors as necessary to clear new floors. Notify Engineer if trimming will violate requirements for fire-rated doors.
3.23 DAMAGED SURFACES

A. Patch and replace any portion of an existing finished surface which is found to be damaged, lifted, or discolored, or shows other imperfections, with matching material.

1. Provide adequate support of substrate prior to patching the finish.

2. Refinish patched portions of painted or coated surfaces in a manner to produce uniform color and texture over entire surface.

3. When existing surface finish cannot be matched, refinish entire surface to nearest intersections, using the same finish used in comparable new work. Obtain approval before beginning the work.

3.04 TRANSITION FROM EXISTING TO NEW WORK

A. When new work abuts or finishes flush with existing work, make a smooth transition. Patched work shall match existing adjacent work in texture and appearance so that the patch or transition is invisible at a distance of five feet.

1. When finished surfaces are cut in such a way that a smooth transition with new work is not possible, terminate existing surface in a neat manner along a straight line at a natural line of division, and provide trim appropriate to finished surface. Obtain approval of proposed trim before beginning the work.

3.75 CLEANING

A. Perform periodic and final cleaning as specified in Section 01770.

B. At completion of work of each trade, clean area and make surfaces ready for work of successive trades.

C. At completion of alterations work in each area, provide final cleaning and return space to a condition suitable for use by Owner.

END OF SECTION
SECTION 01310
COORDINATION

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Administrative and supervisory requirements for coordinating construction.

B. Procedures for review of documents and coordination of construction activity, including preparation of coordination drawings.

C. Coordination with Owner's requirements.

D. Coordination of work of various trades, suppliers, and subcontractors.

1.18 COORDINATION PROCEDURES

A. In accordance with requirements of the General Conditions, before starting each portion of the work, study and compare the various drawings and other contract documents relative to that portion of the work, as well as other information and field measurements and drawings.

B. Examples of items which may require particular field adjustment and coordination include, but are not limited to:

1. Specifications and drawings for equipment and furnishings which require connections to and coordination with associated mechanical and electrical systems and devices.

2. Installation of systems typically shown on contract drawings as diagrams and therefore subject to field adjustment.
   a. Areas where two or more such systems are required to be installed in limited space.

3. Areas subject to several simultaneously applied requirements of mechanical, electrical, and building codes.

C. Immediately report as required by the General Conditions and by procedural and administrative specifications:

1. If, during the coordination review or later during the progress of the work, errors, inconsistencies, or omissions are discovered.

2. If a situation should develop which prevents the proper installation of any equipment or item, or compliance with the contract documents.

D. Coordinate scheduling, submittals and work of the various sections of Specifications to assure efficient, timely, and orderly sequence of installation of construction elements. Provide for accommodating items to be installed later. Coordinate work so that each trade will have completed installations prior to construction which could obstruct their work.

E. Dimensions: Coordinate sizing of various components to assure proper fit and location. Verify dimensions of existing work and of new construction and equipment.
F. Drawings: Various products and systems have been indicated schematically or diagrammatically. Coordinate actual layout and dimensions, and prevent interference between components or trades.

G. Substitution or change: Determine and coordinate the effects. Upon approval of substitution or change in the work, accommodate all the consequent ramifications and costs.

H. Sequence: Coordinate to provide normal progression of the work in a timely manner without delays. Determine long-lead items and the requirements for items on which each sequence is dependent.

I. Individual inspection: Every subcontractor or trade is responsible for reviewing contract documents, and inspecting surfaces, substrates and areas related to the execution of their work.

J. Coordinate trades to insure that proper clearances and access are provided for items which require operation and maintenance.

1.21 COORDINATION MEETINGS

A. In addition to progress meetings specified in Section 01312, hold coordination meetings and preinstallation conferences with personnel and subcontractors to assure coordination of work.

1.30 COORDINATION OF SUBMITTALS

A. Schedule and coordinate submittals. See requirements of the section specifying submittal procedures.

B. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, equipment.

C. Coordinate requests for substitutions to assure compatibility of space, of operating elements and effect on work of other sections.

1.31 COORDINATION SUBMITTALS

A. Coordination drawings: Prepare coordination drawings where careful and detailed coordination is needed, as required for situations described in "Coordination Procedures" above, and where required in other sections of specifications.

1. Show relationships of components shown on separate shop drawings.

2. Show proposed field coordination of systems shown schematically or diagrammatically on contract drawings.

3. Indicate installation sequences.

1.60 COORDINATION OF SPACE

A. Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow route shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Use space efficiently to provide access for other installations, for maintenance, and for repairs.
B. In finished areas conceal pipes, ducts, and wiring in the construction. Coordinate locations of fixtures and outlets with finish elements.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Review of work: Prior to the commencement of work of each section of the specifications, carefully examine previously executed work performed under other sections or by other trades, which might affect execution of work of a section.

B. Acceptance: Commencement of work of a section will indicate acceptance by the Contractor of previously executed surfaces, substrates and areas of work. The commencement indicates that previous work has been inspected and meets the Contractor's requirements for warranty.

3.60 FIELD QUALITY CONTROL

A. A competent superintendent shall be on the premises at all times to check, lay out, coordinate, and superintend the installation of work. Superintendent shall establish grades and lines relative to the work before starting, and be responsible for their accuracy.

B. Coordinate completion and clean-up of work of separate sections in preparation for Substantial Completion.

C. Coordinate access to site by various trades and subcontractors for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

D. Assemble and coordinate closeout submittals specified in Section 01770.

END OF SECTION
SECTION 01312

PROJECT MEETINGS

PART 1 - GENERAL

1.11 SECTION INCLUDES
   A. Preconstruction conference
   B. Progress meetings.

1.14 RELATED SECTIONS
   A. Section 01310 Coordination

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.03 PRECONSTRUCTION CONFERENCE
   A. Owner will conduct conference for execution of Owner - Contractor Agreement.
   B. Owner will conduct conference for clarification of Owner and Contractor responsibilities in use of site and review of administration procedures.

3.04 PROGRESS MEETINGS
   A. Progress meetings shall be held at the job site no less than two weeks apart, and also when and if the Contractor or Engineer finds them necessary or advantageous to progress of work.
   B. Contractor, those subcontractors and those material suppliers concerned with current progress or with the scheduling of future progress, Engineer and Owner shall each be represented at these meetings by persons familiar with the details of work and authorized to conclude matters relating to work progress.
   C. Contractor shall conduct each progress meetings and prepare agenda of meeting with a copy for each attendee. Contractor shall keep accurate minutes of Progress Meetings, wording of which shall be approved by Engineer and shall promptly within two days distribute a sufficient number of copies to all parties.
   D. Contractor shall provide tables and chairs for meetings and a set of drawings and specifications shall be available for use.

END OF SECTION
PART 1 GENERAL

1.11 SUMMARY

A. Submittal procedures.
B. Manufacturer and subcontractor list.
C. Product data, shop drawings, and samples.
D. Manufacturers' instructions.
E. Schedule of values.
F. Manufacturers' certificates.
G. Project schedules.

1.14 RELATED SECTIONS

A. Section 01450 - Quality Control: Manufacturers' field services and reports.
B. Section 01770 - Contract Closeout: Operation and maintenance manuals; certificates and special warranties; closeout submittals.

1.21 DEFINITIONS

A. Coordination drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.

1. Preparation of coordination drawings is specified in Division 1 Section “Coordination” and may include components previously shown in detail on Shop Drawings or Product Data.

1.25 SUBMITTAL PROCEDURES

A. Transmit each submittal with a form or letter of transmittal acceptable to the Engineer.
B. Sequentially number the transmittal forms. Resubmittals to have original number with an alphabetic suffix.
C. Identify project, contractor, subcontractor or supplier, pertinent Drawing sheet and detail number(s), and specification section number, and paragraph, as appropriate. Identify specific service or location for which the item is to be used.
D. Apply Contractor's stamp, signed or initialed certifying that review, verification of products required, field dimensions, adjacent construction work, and coordination of information, is in accordance with the requirements of the work and contract documents.
E. Schedule submittals to expedite the project, and deliver to Engineer at business address. Coordinate submission of related items.
F. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed work.

G. Provide space for Contractor and Engineer review stamps.

H. Revise and resubmit submittals as required, identify all changes made since previous submittal.

I. Contractor's failure to make submittals in time for review and resubmittals shall not be allowed as a reason for extending contract time.

J. Product data and shop drawings will not be reviewed until the manufacturer and subcontractor list has been accepted. Do not order, fabricate, or install any item until it has been reviewed and accepted.

K. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.30 MANUFACTURER AND SUBCONTRACTOR LIST

A. Within 7 days after date of Owner-Contractor Agreement, submit complete list of manufacturers and subcontractors proposed for use, with name of manufacturer, trade name, and model number of each product. A partial or incomplete list will not be accepted.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.31 PRODUCT DATA

A. Submit the number of copies which the Contractor requires, plus two copies which will be retained by the Engineer.

B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this project.

C. The approval of a Shop Drawing or Product Data does not guarantee the measurements or the building conditions or that the Shop Drawings or Product Data have been checked to see that item submitted properly fits the building conditions. Approval shall not relieve the Contractor of the responsibility for furnishing material and performing work as required by the specifications and contract drawings; or the responsibility for verifying correctness of dimensions and quantities, and proper coordination of details and interface among trades.

D. All exclusively electrical items furnished as associated items with mechanical items but not specifically described in the mechanical item submission, shall be submitted as a separate Shop Drawing but shall be clearly marked as associated with the mechanical item by specification paragraph.

E. After review, distribute in accordance with article on Procedures above and provide copies for Record Documents described in Section 01770 - Closeout Procedures.

1.32 SHOP DRAWINGS

A. Submit in the form of one reproducible transparency and one opaque reproduction.

B. Available space for equipment is indicated by the size of equipment shown on the drawings. Suppliers shall ascertain that their equipment will fit the available space. Include with shop
drawings of equipment, drawings showing necessary deviations and changes required in materials and appurtenances made necessary by the units proposed to be furnished. Contractor shall be responsible for required changes without any additional cost.

C. After review, reproduce and distribute in accordance with article on Procedures above and for Record Documents described in Section 01770 - Closeout Procedures.

1.33 SAMPLES

A. Submit samples, where required, to illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

B. Submit samples of finishes from the full range of manufacturers’ standard colors, textures, and patterns for Engineer's selection.

C. Include identification on each sample, with full project information.

D. Submit the number of samples specified in individual specification sections, or two if not specified; one of which will be retained by Engineer.

E. Reviewed samples which may be used in the work are indicated in individual specification sections.

1.34 MANUFACTURER’S INSTRUCTIONS

A. When specified in individual specification sections, submit manufacturers’ printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, in quantities specified for Product Data.

B. Identify conflicts between manufacturers’ instructions and Contract Documents.

1.35 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of Schedule of Values with preparation of the Contractor’s Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:

   a. Contractor’s Construction Schedule.
   b. Application for Payment forms, including Continuation Sheets.
   c. List of subcontractors.
   d. Schedule of alternates.
   e. List of products.
   f. List of principal suppliers and fabricators.
   g. Schedule of submittals.

2. Submit the Schedule of Values at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.

B. Format and content: Use the Project Manual table of contents as a guide to establish the format for the Schedule of Values. Provide at least one line item for each specification section.

1. Identification: Include the following project identification on the Schedule of Values:
a. Project name and location.
b. Name of the Engineer.
c. Project number.
d. Contractor’s name and address.
e. Date of submittal.

2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
   a. Related specification section or division.
   b. Description of work.
   c. Name of subcontractor.
   d. Name of manufacturer or fabricator.
   e. Name of supplier.
   f. Change Orders (numbers) that affect value.
   g. Dollar value.
   h. Percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.

4. Round amounts to nearest whole dollar; the total shall equal the Contract Sum.

5. Provide a separate line item in the Schedule of Values for each part of the work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.

6. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the work.

7. Margins of cost: Show line items for indirect costs and margins on actual costs only when such items are listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.
   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at the Contractor’s option.

C. Schedule updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.43 MANUFACTURER’S CERTIFICATES

A. When specified in individual specification sections, submit manufacturers’ certificate to Engineer for review, in quantities specified for Product Data.

B. Indicate whether material or product conforms to or exceeds specified requirements. Submit supporting reference date, affidavits, and certifications as appropriate.
C. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

1.70 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial progress schedule in duplicate within 15 days after date of Owner-Contractor Agreement for Engineer review.

B. Revise and resubmit as required.

C. Submit revised schedules with each Application for Payment, identifying changes since previous version.

D. Submit computer generated network analysis diagram using the PERT method, generally as outlined in Associated General Contractors of America (AGC) publication "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry".

D. Show complete sequence of construction by activity, identifying work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

E. Indicate estimated percentage of completion for each item of work at each submission.

F. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates, including those furnished by Owner and under Allowances.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

END OF SECTION
SECTION 01410
REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. As a convenience to users of the contract documents, listings of organizations and their common acronyms or abbreviations which are referred to in the documents or which are among the authorities having jurisdiction.

B. Description of submittals required for conformance to regulatory requirements.

1.30 SUBMITTALS

A. Secure certificates of approval from specified or other approved testing agencies, inspection agencies, and authorities having jurisdiction. Certificates shall cover all work, including, but not limited to, plumbing, ductwork, fire protection, and electrical. Submit certificates of approval prior to final acceptance of the work.

B. Obtain, including the expediting of all necessary signatures and paperwork, permits, fees, and inspections required by city, county, state, or federal authorities having jurisdiction. Owner will pay directly for the costs of these certificates, permits, fees, inspections, and connections.

1.40 QUALITY ASSURANCE

A. When these specifications call for materials or construction of a better quality or larger sizes than required by the codes and standards of the regulatory authorities or industry organizations, the provisions of the specifications shall take precedence.

B. Provide without extra charge, additional materials and labor which may be required for compliance with these codes and standards even though the work is not mentioned in these specifications or shown on the contract drawings.

C. Materials, equipment or workmanship specified by reference to number, symbol, or title of any industry or government agency standard shall comply with the applicable provisions of such standard, except as limited to type, class, or grade, or modified in contract specifications. Standards referred to in the specifications, except as modified, shall have full force and effect as though printed in detail in specifications.

D. Regulatory authorities: The work covered under these specifications shall be performed in accordance with the applicable requirements of the authorities having jurisdiction. The applicable edition of a regulatory code is as defined by the authority. Where code standards are referred to, comply with standards and revisions in effect as of the date of the contract documents. The applicable regulatory authorities include, but are not limited to:

1. The plumbing, mechanical, electrical, building, fire, and safety codes of the state and county or city in which the work is being performed.

2. The state department of health.


5. Insurance Service Office of Maryland.
E. Trade associations and standards: The following abbreviations and acronyms, when referred to in the contract documents, mean the organizations identified below. Names and addresses are subject to change and are believed, but not assured, to be correct as of the date of the contract documents.

**AA**  
Aluminum Association  
900 19th St., NW, Suite 300  
Washington, DC 20006  
www.aluminum.org  
(202) 862-5100

**AABC**  
Associated Air Balance Council  
1518 K St., NW, Suite 503  
Washington, DC 20005  
www.aabchq.com  
(202) 737-0202

**AAMA**  
American Architectural Manufacturers Association  
1827 Walden Office Sq., Suite 104  
Schaumburg, IL 60173-4268  
www.aamanet.org  
(847) 303-5664

**ACI**  
American Concrete Institute  
P.O. Box 9094  
Farmington Hills, MI 48333-9094  
www.aci-int.org  
(248) 848-3700

**ACIL:**  
The Association of Independent Scientific, Engineering, and Testing Firms  
1629 K St., NW, Suite 400  
Washington, DC 20006  
www.acil.org  
(202) 887-5872

**ADC**  
Air Diffusion Council  
11 South LaSalle St., Suite 1400  
Chicago, IL 60603  
(312) 201-0101

**AEIC**  
Association of Edison Illuminating Companies  
600 N. 18th St.  
P.O. Box 2641  
Birmingham, AL 35291-0992  
(205) 250-2530

**AFPA**  
American Forest and Paper Association  
(Formerly: National Forest Products Association)  
1111 19th St., NW, Suite 800  
Washington, DC 20036  
(800) 878-8878  
(202) 463-2700

**AGMA**  
American Gear Manufacturers Association (AGMA)  
1500 King Street, Suite 201  
Alexandria, VA 22314-2730  
(703) 684-0211

Order Publications From:

UMBC Patapsco Hall  
© 2003 James Posey Associates, Inc. 4938-01 (41)  
Regulatory Requirements  
01410 - 2
Global Engineering Documents
(800) 854-7179
15 Inverness Lane East
Englewood, CO 80112

AISC  American Institute of Steel Construction
One East Wacker Dr., Suite 3100
Chicago, IL 60601-2001
(800) 644-2400
(312) 670-2400

AISI  American Iron and Steel Institute
1101 17th St., NW
Washington, DC 20036-4700
www.steel.org
(202) 452-7100

AMCA  Air Movement and Control Association
International, Inc.
30 W. University Dr.
Arlington Heights, IL 60004-1893
www.amca.org
(847) 394-0150

ANSI  American National Standards Institute
11 West 42nd St., 13th Floor
New York, NY 10036-8002
www.ansi.org
(212) 642-4900

AREA  American Railway Engineering Association
50 F Street, N.W., Suite 5200
Washington, D.C. 20001
(202) 639-2190

ARI  Air-Conditioning and Refrigeration Institute
4301 Fairfax Dr., Suite 425
Arlington, VA 22203
www.ari.org
(703) 524-8800

ASHRAE  American Society of Heating, Refrigerating and Air-Conditioning Engineers
1791 Tullie Circle, NE
Atlanta, GA 30329-2305
www.ashrae.org
(800) 527-4723
(404) 636-8400

ASME  American Society of Mechanical Engineers
345 East 47th St.
New York, NY 10017-2392
www.asme.org
(800) 434-2763
(212) 705-7722

ASPE  American Society of Plumbing Engineers
8614 W. Catalpa Ave., Ste 1007-1009
Chicago, IL 60656-1116
(805) 495-7120

ASSE  American Society of Sanitary Engineering
(216) 835-3040
<table>
<thead>
<tr>
<th>Organization</th>
<th>Address</th>
<th>Phone Numbers</th>
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<tbody>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
<td>(610) 832-9500</td>
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<tr>
<td></td>
<td>100 Barr Harbor Dr.</td>
<td></td>
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<tr>
<td></td>
<td>West Conshohocken, PA 19428-2959</td>
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<td></td>
<td><a href="http://www.astm.org">www.astm.org</a></td>
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<tr>
<td>AWI</td>
<td>Architectural Woodwork Institute</td>
<td>(703) 733-0600</td>
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<tr>
<td></td>
<td>1952 Isaac Newton Sq.</td>
<td></td>
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<tr>
<td></td>
<td>Reston, VA 20190</td>
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<td></td>
<td><a href="http://www.awinet.org">www.awinet.org</a></td>
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<tr>
<td>AWS</td>
<td>American Welding Society</td>
<td>(800) 443-9353</td>
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<tr>
<td></td>
<td>550 NW LeJeune Rd.</td>
<td>(305) 443-9353</td>
</tr>
<tr>
<td></td>
<td>Miami, FL 33126</td>
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<td></td>
<td><a href="http://www.amweld.org">www.amweld.org</a></td>
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<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
<td>(800) 926-7337</td>
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<tr>
<td></td>
<td>6666 W. Quincy Ave.</td>
<td>(303) 794-7711</td>
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<tr>
<td></td>
<td>Denver, CO 80235</td>
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<td></td>
<td><a href="http://www.awwa.org">www.awwa.org</a></td>
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<tr>
<td>CBM</td>
<td>Certified Ballast Manufacturers Association</td>
<td>(216) 241-0711</td>
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<tr>
<td></td>
<td>1422 Euclid Ave., Suite 402</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cleveland, OH 44115-2094</td>
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<tr>
<td>CDA</td>
<td>Copper Development Association Inc.</td>
<td>(800) 232-3282</td>
</tr>
<tr>
<td></td>
<td>260 Madison Ave., 16th Floor</td>
<td>(212) 251-7200</td>
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<tr>
<td></td>
<td>New York, NY 10016</td>
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<td></td>
<td><a href="http://www.copper.org">www.copper.org</a></td>
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<tr>
<td>CISPI</td>
<td>Cast Iron Soil Pipe Institute</td>
<td>(423) 892-0137</td>
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<tr>
<td></td>
<td>5959 Shallowford Rd., Suite 419</td>
<td></td>
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<tr>
<td></td>
<td>Chattanooga, TN 37421</td>
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<tr>
<td>EEI</td>
<td>Edison Electric Institute (EEI)</td>
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<tr>
<td></td>
<td>90 Park Avenue</td>
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<tr>
<td></td>
<td>New York, NY 10016</td>
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<tr>
<td>EIA</td>
<td>Electronic Industries Association</td>
<td>(703) 907-7500</td>
</tr>
<tr>
<td></td>
<td>2500 Wilson Blvd.</td>
<td></td>
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<tr>
<td></td>
<td>Arlington, VA 22201</td>
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<tr>
<td>ETL</td>
<td>ETL Testing Laboratories, Inc. (Now part of ITS)</td>
<td></td>
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<tr>
<td>FM</td>
<td>Factory Mutual System</td>
<td>(781) 762-4300</td>
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<tr>
<td></td>
<td>1151 Boston-Providence Tnpk.</td>
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<tr>
<td></td>
<td>P.O. Box 9102</td>
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<tr>
<td></td>
<td>Norwood, MA 02062-9102</td>
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<tr>
<td></td>
<td><a href="http://www.factorymutual.com">www.factorymutual.com</a></td>
<td></td>
</tr>
</tbody>
</table>
HI  Hydraulic Institute  
   9 Sylvan Way  
   Parsippany, NJ 07054-3802  
   (201) 267-9700

IEEE  Institute of Electrical and  
Electronics Engineers  
345 E. 47th St.  
New York, NY 10017-2394  
www.ieee.org  
   (800) 678-4333  
   (212) 705-7900

IRI  Industrial Risk Insurers  
P.O. Box 5010  
85 Woodland St.  
Hartford, CT 06102-5010  
   (860) 520-7300

ITS  Intertek Testing Services  
(Formerly: Inchcape Testing  
   Services)  
P.O. Box 2040  
3933 US Route 11  
Cortland, NY 13045-7902  
www.itsglobal.com  
   (800) 345-3851  
   (607) 753-6711

MSS  Manufacturers Standardization Society  
of the Valve and Fittings Industry  
127 Park St., NE  
Vienna, VA 22180-4602  
   (703) 281-6613

NAAMM  National Association of Architectural  
Metal Manufacturers  
8 South Michigan Ave., Suite 1000  
Chicago, IL 60603  
www.gss.net/naamm  
   (312) 456-5590

NAIMA  North American Insulation  
Manufacturers Association  
(Formerly: Thermal Insulation  
Manufacturers Association)  
44 Canal Center Plaza, Suite 310 
Alexandria, VA 22314  
www.naima.org  
   (703) 684-0084

NEBB  Natural Environmental Balancing  
Bureau  
8575 Grovemont Circle  
Gaithersburg, MD 20877-4121  
   (301) 977-3698

NEMA  National Electrical Manufacturers  
Association  
1300 N 17th St., Suite 1847  
Rosslyn, VA 22209  
www.nema.org  
   (703) 841-3200

NETA  InterNational Electrical Testing  
Association  
P.O. Box 687  
   (303) 697-8441
106 Stone St.
Morrison, CO 80465-1526
www.electricnet.com/neta

NFPA  National Fire Protection Association
One Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
www.nfpa.org

(800) 344-3555
(617) 770-3000

NSF  NSF International
(Formerly: National Sanitation Foundation)
P.O. Box 130140
Ann Arbor, MI 48113-0140
www.nsf.org

(313) 769-8010

PDI  Plumbing and Drainage Institute
45 Bristol Dr., Suite 101
South Easton, MA 02375

(800) 589-8956
(508) 230-3516

PPI  Plastic Pipe Institute
(The Society of the Plastics Industry, Inc.)
1801 K St., NW, Suite 600L
Washington, DC 20006
www.plasticpipe.org

(202) 974-5306

SMACNA  Sheet Metal and Air Conditioning Contractors' National Association, Inc.
4201 Lafayette Center Dr.
P.O. Box 221230
Chantilly, VA 20151-1209
www.smacna.org

(703) 803-2980

SSPC  Steel Structures Painting Council
40 24th St., 6th Floor
Pittsburgh, PA 15222-4643

(412) 281-2331

TIMA  Thermal Insulation Manufacturers Association
(See NAIMA)

UL  Underwriters Laboratories Inc.
333 Pfingsten Rd
Northbrook, IL 60062
www.ul.com

(800) 704-4050
(847) 272-8800

F. Federal government agencies: Names and titles of federal government standards- or specification-producing agencies are often abbreviated. The following abbreviations and acronyms referred to in the Contract Documents indicate names of standards- or specification-producing agencies of the federal government. Names and addresses are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.
1.41 OTHER REFERENCES

A. Maryland Occupational Safety and Health Act (MOSHA)  
State of Maryland Department of Health and Mental Hygiene  
201 W. Preston Street, Baltimore, MD 21201

B. Standardized Plant Names, Published by J. Horace McFarland, Harrisburg, PA, for the  
American Joint Committee on Horticultural Nomenclature.

C. Applicable state, city and county standard details and design manuals for water mains, sanitary  
standards, and storm details.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION
SECTION 01450
QUALITY CONTROL

PART 1 GENERAL

1.11 SECTION INCLUDES

A. Quality assurance and control of installation.
B. References.
C. Inspection and testing laboratory services.
D. Tests of mechanical and electrical systems and equipment.
E. Manufacturers' field services and reports.

1.14 RELATED SECTIONS

A. Submittals: Section 01300.
B. Requirements for material and product quality: Section 01600.
C. Testing, adjusting, and balancing of mechanical equipment: Section 15950.

1.19 REFERENCES

A. Conform to reference standard by date of issue current on date of Contract Documents.
B. Obtain copies of standards when required by Contract Documents.
C. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.40 QUALITY ASSURANCE

A. The Specifications and Drawings are intended to define the minimum requirements, as to quality of materials, construction, finish and overall workmanship.
B. In case of discrepancies between the specifications and drawings, the specifications should be followed as to the general methods and principles and the drawings followed as to sizes, capacities and specifics for corresponding parts. If sizes are omitted, the Engineer will determine sizes to be used.
C. In all cases of doubt, uncertainty or conflict as to the true meaning of the specifications or drawings it is the responsibility of the Contractor to notify the Engineer and obtain a decision as to the intent, before initiating any work which may be affected by this decision.

1.47 SPECIALIST

A. The term "specialist" as used in the specification shall mean an individual or firm of established reputation (or, if newly organized, whose personnel have previously established a reputation in
the same field,) which is regularly engaged in, and which maintains a regular force of workers skilled in either (as applicable) manufacturing or fabricating items required by the contract, installing items required by the contract, or otherwise performing work required by the Contract. Where the contract specification requires installation by a specialist, the term shall also be deemed to mean either the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform the work under the manufacturer's direct supervision.

B. Specialist shall submit a list of a minimum of three projects of similar type, size and duty, which have been performed for not less than five years.

C. List shall include project name, address, name and phone number of Owner's Representative, project size and type.

1.48 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply fully with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform work by persons qualified to produce workmanship of specified quality.

F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

PART 2 - PRODUCTS  (Not used)

PART 3 - EXECUTION

3.61 TESTS

A. Furnish all labor, specialties, equipment, services, and appurtenances required for the tests, and pay any other expenses incurred, including necessary changes to the systems as required to produce the specified results.

B. Conduct all tests before any equipment is connected that would be subject to damage from the test pressure, and voltage.

C. Notify all parties whose presence is necessary for the test. Notify Engineer at least two days prior to the actual test.

D. Perform specific tests on the systems and equipment installed as work of Division 15, Mechanical, and Division 16, Electrical, and specified in technical sections.

E. Tests shall be performed in accordance with the requirements of the applicable codes and as herein specified. The entire installation shall be proven complete and in readiness for regular and satisfactory use.
F. Equipment, materials and workmanship found at fault during tests shall be replaced, repaired or made good to satisfaction of the Engineer, and test repeated.

3.62 INSPECTION AND TESTING LABORATORY SERVICES

A. Contractor shall employ and pay for services of an independent testing laboratory to perform specified inspection and testing.

B. The independent firm will perform inspections, tests, and other services specified in individual specification sections and as required by the Engineer.

C. Reports will be submitted by the independent firm to the Engineer, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

D. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.
   1. Notify Engineer and independent firm 24 hours prior to expected time for operations requiring services.
   2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

E. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Engineer. Payment for retesting will be charged to the Contractor by the testing laboratory.

3.63 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. Submit qualifications of observer to Architect/Engineer 30 days in advance of required observations. Observer subject to approval of Engineer.

B. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment and to initiate instructions when necessary.

C. Individuals to report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

D. Submit report in duplicate within 30 days of observation to Engineer for review.

END OF SECTION
SECTION 01500
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.11 SECTION INCLUDES

A. Temporary utilities: Electricity, lighting, heat, ventilation, telephone service, water, and sanitary facilities.

B. Temporary controls: Barriers, enclosures and fencing, protection of the work, and water control.

C. Construction facilities: Access roads, parking, progress cleaning, project signage, and temporary buildings.

1.14 RELATED SECTIONS

A. Project meetings: Section 01312.

B. Erosion and sediment controls: Section 01570.

C. Project closeout: Section 01770.

PART 2 - PRODUCTS

2.01 Products shall comply with applicable sections of Division 2 through 16 and shall be commercial grade.

PART 3 - EXECUTION

3.30 APPLICATION

3.31 TEMPORARY ELECTRICITY

A. Connect to existing power service. Power consumption for construction shall not disrupt Owner’s continuous service.

B. Owner will pay cost of energy used. Exercise measures to conserve energy.

C. Temporary power service: Of sufficient size, capacity, and characteristics to accommodate performance of the work.

D. Provide power outlets for construction operations, with branch wiring and distribution boxes located within 100 ft of each work area. Provide flexible power cords as required.

E. Permanent convenience receptacles may be utilized during construction.

F. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.

1. Provide 20 ampere duplex outlets, single phase circuits for power tools.

2. Provide 20 ampere, single phase branch circuits for lighting.
3.32 TEMPORARY LIGHTING

A. Provide and maintain lighting for construction operations.

B. Provide and maintain 1 watt/sq ft lighting to exterior staging and storage areas after dark for security purposes.

C. Provide and maintain 0.25 watt/sq ft H.I.D. lighting to interior work areas after dark for security purposes.

D. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.

E. Maintain lighting and provide routine repairs.

F. Use permanent building lighting during construction as needed.

3.33 TEMPORARY HEAT

A. Provide and pay for heat devices and heat as required to maintain specified conditions for construction operations.

B. Owner will pay cost of energy used. Exercise measures to conserve energy. Enclose building prior to activating temporary heat in accordance with Article "Exterior Enclosures" in this section.

C. Prior to operation of permanent equipment for temporary heating purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

D. Maintain minimum ambient temperature of 50 degrees F in areas where construction is in progress, unless indicated otherwise in specifications.

3.34 TEMPORARY VENTILATION

A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

B. Use existing ventilation equipment. Extend and supplement equipment with temporary fan units as required to maintain clean air for construction operations.

C. Prevent dust or fumes from construction work from entering building ventilation systems.

3.35 TELEPHONE SERVICE

A. Provide, maintain and pay for telephone service to field office at time of project mobilization.

3.36 TEMPORARY WATER SERVICE

A. Connect to existing water source for construction operations.

B. Owner will pay cost of water used. Exercise measures to conserve water.

C. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.
3.37 Temporary Sanitary Facilities

A. Existing permanent designated facilities may be used during construction operations. Maintain daily in clean and sanitary condition.

B. At end of construction, return facilities to same or better condition than originally found.

3.38 Barriers

A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Provide barricades, temporary stairs, rails, screens, and covered walkways required by governing authorities for public rights-of-way. Provide access, staging, and protection as necessary for proper handling of work.

C. Provide protection for plant life not designated to be removed. Replace damaged plant life.

D. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

3.39 Fencing

A. Construction: Commercial grade chain link fence.

B. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

3.41 Exterior Enclosures

A. Provide temporary insulated weather-tight closure of exterior openings to accommodate acceptable working conditions and protection for products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification Sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

3.42 Interior Enclosures

A. Provide temporary partitions as required to prevent damage to existing materials and equipment.

B. Construction: Framing and plywood sheet materials with closed joints and sealed edges at intersections with existing surfaces.

3.43 Protection of Installed Work

A. Protect installed work and provide special protection where specified in individual specification Sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate work area to minimize damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
E. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

G. Each trade and subcontractor is responsible for preventing damage and soiling of work performed by other trades or subcontractors. Each trade and subcontractor is responsible for providing temporary protection of its own work.
   1. Protect work from spills, splatters, dippings, adhesives, bitumens, mortars, paints, plasters, welding or burning.
   2. Protect finished work from damage, defacement, staining, or scratching.
   3. Protect finish work from cleaning agents, or grinding and finishing equipment.
   4. Protect adjacent and finished work from damage, using tape, masking, covers or coatings and protective enclosures.
   5. Coordinate installations and temporarily remove items to avoid damage from finishing work.

H. Repair damage and soiling to the complete satisfaction of the Engineer; replace any materials or work damaged to such an extent that they cannot be restored to their original condition, at no addition to the Contract Sum.

3.45 FIRE PROTECTION

A. As a minimum, provide hand-carried, portable, UL-rated extinguishers with each work crew working inside the building.

B. Select extinguishers in accordance with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

3.46 SCAFFOLDING, TARPAULINS

A. Wood Scaffolding: Do not use wood scaffolding, except for deck planking. All supporting members shall be of metal.

B. Tarps: Certified flame retardant in accordance with NFPA 701.

3.47 SAFETY

A. Safety requirements of the Maryland Occupational Safety Authority supercede the following safety suggestions and shall govern all work on this project.
   1. Contact Owner’s representative before starting any work.
   2. Make sure all objects attached to walls or ceilings are securely fastened.
   3. Do not work overhead of Owner’s personnel.
   4. When cutting or chipping concrete, protect against spalling below and against flying chips.
5. Do not block doors with ladders; if blocking is necessary, place a "Caution" sign on other side of door.

6. Keep the work area clear of debris or other items over which people might trip.

3.48 HEAVY EQUIPMENT

A. Provide, either through own organization or through subcontractors, all construction cranes, and other rigging, concrete lifts, chutes, and the like required for completion of work.

B. All such construction shall be carried out in conformance with local codes and subject to the approval of Engineer. Do not locate or move cranes, chutes or other heavy equipment in such a manner as to damage or strain the framework of any building. Contractor shall be responsible for the integrity of the site and shall replace any and all construction damaged by the use of equipment.

C. Contractor and its subcontractors shall be entirely responsible for the proper handling and safety of all equipment used.

3.49 SECURITY

A. Provide security and facilities to protect work, and existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

B. Coordinate with Owner's security program.

3.50 ACCESS ROADS

A. Designated existing on-site roads may be used for construction traffic.

B. Use of sidewalks or roads outside the property lines shall be with permission and approval of the authorities having jurisdiction.

3.52 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Remove waste materials, debris, and rubbish from site daily and dispose off-site.

3.54 FIELD OFFICES AND SHEDS

E. Office: Weather-tight, with lighting, electrical outlets, heating, cooling and ventilating equipment, and equipped with sturdy furniture.

F. Provide space for project meetings, with table and chairs to accommodate 10 persons.

3.55 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS
A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Substantial Completion inspection.

B. Remove underground installations to a minimum depth of 2 feet.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

END OF SECTION
SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.11 SECTION INCLUDES

A. Products.

B. Product options.

C. Substitutions.

D. Delivery, storage, and handling.

1.14 RELATED SECTIONS

A. Section 01450 - Quality Control: Product quality monitoring.

1.20 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the work. Products may also include existing materials or components required for reuse.

B. Labeling and testing electrical components and equipment: As specified in Mechanical and Electrical Basic Materials and Methods.

C. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

D. Provide interchangeable components of the same manufacturer, for similar components.

E. All products and materials shall be of the specified level of quality, suitable for the conditions and expected performance of the project, and of standard manufacture.

F. All equipment, construction and installation must meet requirements of local, state and federal governing codes.

G. Singular number: In cases where material, a device, or part of the equipment is referred to in the singular number in the specifications, it is intended that such reference shall apply to as many items of material, devices, or parts of the equipment as are required to complete the installation as shown on the drawings or required for proper operation of the system.

1.21 PRODUCT OPTIONS

A. General: Where Contractor is permitted to use a product other than the specific item and model named as the basis of design, Contractor is responsible for all coordination and additional costs as specified in article 1.22 for substitutions.

B. Products specified by reference standards or by description only: Any product meeting those standards or description.
C. Products specified by naming one or more manufacturers, or model name or catalog reference number: Products specified establish a standard of quality, options to be included, and performance.

1. Where other acceptable manufacturers are named, Contractor may provide products only of those manufacturers, which meet the specifications.

2. Where specification permits "equal" products, without naming other acceptable manufacturers, Contractor may use products of any manufacturer, which meet the specifications.

C. Products specified by naming one or more manufacturers, or model name or catalog reference number: Products specified establish a standard of quality, options to be included, and performance, and shall not be construed as limiting competition. Contractor may use products of any manufacturer, which meet the specifications.

D. Products specified by naming one manufacturer or particular product, with no provision for other options: No options or substitutions allowed.

1.22 SUBSTITUTIONS

A. Engineer will consider requests for Substitutions only as permitted in Instructions to Bidders and General Conditions.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that the Contractor:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.

2. Will provide the same warranty for the Substitution as for the specified product.

3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.

4. Waives claims for additional costs or time extension which may subsequently become apparent.

5. Will reimburse Owner for review or redesign services associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitution submittal procedure:

1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence.

3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

1.50 DELIVERY, STORAGE AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

D. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.

E. For exterior storage of fabricated products, place on sloped supports, above ground.

F. Provide off-site storage and protection when site does not permit on-site storage or protection.

G. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

H. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

I. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

J. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

K. Ship equipment in sections of suitable size for entering the building. Make all necessary arrangements for bringing equipment into the building and installing it in its ultimate location.

L. Deliver all package products to the job site in manufacturer's unopened, original, standard containers with grade seals unbroken and labels intact.

M. All materials received on the site shall be clean or be cleaned upon arrival.

N. Laterally brace stacks and piles of materials.

O. Metals shall be free of mud, ice, frost, rust or foreign materials which will damage the finish.

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

3.60 FIELD QUALITY CONTROL

A. All materials and equipment shall be installed and completed in a first class and workmanlike manner and in accordance with the best modern methods, practice and manufacturer's
instructions. Any work which does not present an orderly and neat or workmanlike appearance shall be removed and replaced when so directed in writing by the Engineer.

END OF SECTION
SECTION 01731
CUTTING AND PATCHING

PART 1 GENERAL

1.11 SECTION INCLUDES
   A. Requirements and limitations for cutting and patching of work.

1.14 RELATED SECTIONS
   A. Section 01100 - Summary of work: Work by Owner or by separate contractors.
   B. Section 01330 - Submittal Procedures.
   C. Section 01600 - Product Requirements: Product options and substitutions.
   D. Individual product specification sections:
      1. Cutting and patching incidental to work of the section.
      2. Advance notification to other sections of openings required in work of those sections.
      3. Limitations on cutting structural members.

1.30 SUBMITTALS
   A. Submit written request in advance of cutting or alteration which affects:
      1. Structural integrity of any element of project.
      2. Integrity of fire rating of any fire-rated assembly.
      3. Integrity of weather-exposed or moisture-resistant element.
      4. Efficiency, maintenance, or safety of any operational element.
      5. Visual qualities of sight exposed elements.
      6. Work of Owner or separate contractor.

   B. Include in request:
      1. Identification of project.
      2. Location and description of affected work.
      3. Necessity for cutting or alteration.
      4. Description of proposed work, and products to be used.
      5. Alternatives to cutting and patching.
      6. Effect on work of Owner or separate contractor.
7. Written permission of affected separate contractor.
8. Date and time work will be executed.

C. Submit evidence of Specialist's experience.

1.60 PROJECT CONDITIONS

A. If, in the course of the work, workers encounter a material they suspect to be asbestos, to contain lead or PCBs, or to present some other hazard:
   1. Promptly notify the Owner and Engineer in writing.
   2. Do not perform any work which would disturb the suspected material until written instructions have been received.

B. Drawings showing utilities in concealed locations are based on the best information available but are not represented as being precisely correct. Work of the contract includes digging, cutting, drilling, using nondestructive methods, and other methods of locating concealed utilities in the field.

PART 2 PRODUCTS

2.10 MATERIALS

A. Primary products: Those required for original installation. Comply with contract requirements.

B. Product substitution: For any proposed change in materials, submit request for substitution as required in Section 01600.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching.

B. After uncovering existing work, inspect conditions affecting performance of work.

C. Report unsatisfactory or questionable conditions to Engineer in writing; do not proceed with work until Engineer has provided further instructions.

D. Beginning of cutting or patching means acceptance of existing conditions.

3.05 PREPARATION

A. Provide temporary supports to ensure structural integrity of the work. Provide devices and methods to protect other portions of project from damage.

B. Provide protection from elements for areas which may be exposed by uncovering work.

C. Maintain excavations free of water.

3.08 CUTTING AND PATCHING

A. Execute cutting, fitting, and patching including excavation and fill to complete work.
B. Fit products together, to integrate with other work.

C. Uncover work to install ill-timed work.

D. Remove and replace defective or non-conforming work.

E. Remove samples of installed work for testing when requested.

F. Provide openings in the work for penetration of mechanical and electrical work.

3.20 PERFORMANCE

A. Execute work by methods to avoid damage to other work, and which will provide appropriate surfaces to receive patching and finishing.

B. Where possible, employ original installer to perform cutting and patching for weather exposed and moisture resistant elements, and sight-exposed surfaces.

C. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval. Neatly cut holes and slots to size required, with minimum disturbance to adjacent work; cut holes in concrete slabs for pipes and conduit with core drills of proper sizes. Openings shall be covered temporarily when not in use and patched as soon as work is installed.

   1. Do not cut or core drill floor slab until reinforcing steel in the area to be cut has been located, and penetration has been designed so that it will not damage reinforcing.

   2. Method for location: Non-destructive testing using a calibrated metal detector (R-meter type).

D. Restore work with new products in accordance with requirements of Contract Documents.

E. Fit work to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

F. Where patching fire-rated assemblies, restore each assembly with materials and methods to maintain its fire rating.

G. At penetrations of fire-rated walls, partitions, ceilings, or floors, completely seal voids with firestopping material in accordance with Section 07840, to full thickness of the penetrated element.

H. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

3.21 WORK BY SPECIALIST

A. Cabinet work:

   1. All work in connection with the cutting, drilling, removing, replacing and additions of wood work shall be done by a "Specialist" as specified in Section 01450.

   2. Submit name and credentials of cabinetmaker along with subcontractors list as specified in Section 01330. Cabinetmaker shall present at least five installations of the same type and duty and have performed for not less than 10 years.

END OF SECTION
PART 1 - GENERAL

1.10 SUMMARY

A. This section includes the following:

1. Demolition and removal of selected portions of a building or structure.
2. Demolition and removal of selected site elements.
3. Repair procedures for selective demolition operations.

B. Related sections include the following:

1. Division 1 Section Cutting and Patching for cutting and patching procedures for selective demolition operations.
2. Division 15 Sections for demolishing, cutting, patching, or relocating mechanical items.
3. Division 16 Sections for demolishing, cutting, patching, or relocating electrical items.

1.20 REFERENCES

A. ANSI A10.6: Safety Requirements for Demolition.


1.21 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and salvage: Detach items from existing construction and deliver them to Owner.

C. Remove and reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

D. Existing to remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.22 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.30 SUBMITTALS

A. Qualification data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
B. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

C. Landfill records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous or regulated wastes.

1.40 QUALITY ASSURANCE

A. Demolition firm qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this project.

B. Regulatory requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards: Comply with ANSI A10.6 and NFPA 241.

1.60 PROJECT CONDITIONS

A. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
   1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.

B. Owner assumes no responsibility for condition of areas to be selectively demolished.
   1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Hazardous materials: It is not expected that hazardous materials will be encountered in the work.
   1. Hazardous materials will be removed by Owner before start of the work.
   2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

D. Storage or sale of removed items or materials on-site will not be permitted.

E. Utility service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

F. Maintain fire-protection facilities in service during selective demolition operations.

1.80 WARRANTY

A. Existing warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.10 REPAIR MATERIALS

A. Use repair materials identical to existing materials.
1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

2. Use materials whose installed performance equals or surpasses that of existing materials.

B. Comply with material and installation requirements specified in individual specification sections.

PART 3 - EXECUTION

3.02 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

D. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

3.03 UTILITY SERVICES

A. Existing utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.

B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

1. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.

C. Utility requirements: Refer to Division 15 and 16 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.05 PREPARATION

A. Dangerous materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.

B. Site access and temporary controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Maintain streets and walkways, erect temporary protection, and protect existing site improvements as required in Section 01500, Temporary Facilities and Controls.

2. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
C. Temporary shoring: Provide and maintain shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

3.40 POLLUTION CONTROLS

A. Dust control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.

B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

1. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

C. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.41 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.

5. Maintain adequate ventilation when using cutting torches.

6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove large objects and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

9. Dispose of demolished items and materials promptly.

10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

B. Existing facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.

C. Existing Items to remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

D. Concrete: Demolish in small sections. Cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.

E. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

F. Concrete slabs-on-grade: Saw-cut perimeter of area to be demolished, then break up and remove.

G. Air-conditioning equipment: Remove equipment as specified in Section 15055, Mechanical Demolition.

3.45 PATCHING AND REPAIRS

A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.

B. Patching: Comply with Section 01731, Cutting and Patching.

3.49 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

END OF SECTION
SECTION 01770
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Closeout procedures.
B. Final cleaning.
C. Adjusting.
D. Project record documents.
E. Operation and maintenance data.
F. Warranties.
G. Spare parts and maintenance materials.

1.14 RELATED SECTIONS

A. Submittals: Section 01330.
B. Cleaning: Section 01500.
C. Testing, adjusting, and balancing: Section 15950.
D. Special project warranties: Individual technical sections, Divisions 2-16.

1.30 SUBMITTALS

A. Closeout procedures:

1. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Engineer’s inspection.

2. Provide submittals to Engineer that are required by governing or other authorities.

3. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Project record documents:

1. Maintain on site, one set of the following record documents; record actual revisions to the work:

   b. Specifications.
   c. Addenda.
d. Change Orders and other Modifications to the Contract.

e. Reviewed shop drawings, product data, and samples.

2. Maintain record documents separate from documents used for construction.

3. Record information concurrent with construction progress.

4. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   a. Manufacturer’s name and product model and number.
   b. Product substitutions or alternates utilized.
   c. Changes made by Addenda and Modifications.

5. Record documents and shop drawings: Legibly mark each item to record actual construction including:
   b. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   c. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   d. Field changes of dimension and detail.
   e. Details not on original Contract Drawings.

6. Delete Engineer title block and seal from all documents.

7. Submit documents to Engineer.

C. Operation and maintenance data:

1. Submit three sets.

2. Lubrication charts: Prepare lubrication charts for each piece of mechanical equipment that requires grease or oil, including the following:
   a. Types of lubricants required.
   b. Locations of lubrication points.
   c. Frequency of lubrication.
   d. Provide one extra set of lubrication charts mounted in plastic covers, besides those required in Operating and Maintenance Manuals.

3. Binders: Three-ring binders with vinyl-covered hard covers. Provide large enough binders, and sufficient quantity, that the required contents can be easily turned, removed, and reinserted.
4. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", and title of project. Print on spine of binder "O & M INSTRUCTIONS". If more than one binder is required, print covers and spines with volume numbers. Include in the front of every binder an index to all binders.

5. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

6. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, typed on white paper.

7. Part 1: Directory, listing names, addresses, and telephone numbers of civil, structural, mechanical, and electrical engineers; contractor; subcontractors; and major equipment suppliers.

8. Part 2: Operation and maintenance instructions, arranged by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
   a. Significant design criteria, including pump and fan curves and similar performance charts.
   b. List of equipment, including operating weights.
   c. Parts list for each component, including recommended spare parts list.
   d. Operating instructions.
   e. Maintenance instructions for equipment and systems.
   f. Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
   g. Valve charts, including locations of flow fittings.

9. Part 3: Project documents and certificates, including the following:
   a. Shop drawings and product data.
   b. Air and water balance reports.
   c. Photocopies of certificates.
   d. Photocopies of warranties and guarantees, and bonds.
   e. Test reports: Copies of the results of all tests required under all sections of specifications.

10. Submit one copy of completed volumes in final form 15 days prior to final inspection. This copy will be returned after final inspection, with Engineer comments. Revise content of documents as required prior to final submittal.

11. Submit final volumes revised, within ten days after final inspection.

1.80 WARRANTIES
A. All work and equipment provided as work of the Contract shall be fully warranted under the general project warranty. In addition, provide added special warranties as specified in individual sections.

B. During the correction period, the Contractor shall promptly correct any work found to be defective, or otherwise not in accordance with the requirements of the Contract Documents, on receipt of written notice from the Owner. Except as otherwise required in general conditions, the correction period is one year after the date of substantial completion of the work. Work requiring correction shall promptly be repaired or completely replaced at no addition to the Contract Sum.

C. When use of the permanent equipment has been permitted for temporary heating or ventilation of the building, the warranty and correction periods shall nevertheless begin at the time of substantial completion, unless another date of acceptance has been on agreed to in writing by the Owner.

D. Special warranties are warranties required by individual specification sections, incidental product warranties, manufacturers' standard warranties, installer or subcontractor service agreements, and other individual warranties in addition to the general project warranty.

E. Provide duplicate notarized copies.

F. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.

G. Submit to Owner prior to final Application for Payment.

H. For items of work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.92 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification sections.

B. Deliver to project site and place in location as directed; obtain receipt prior to final payment.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.70 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.71 LUBRICATION

A. Bearings of equipment shall be provided with adequate facilities for lubrication. Oiling devices, fittings, and appurtenances shall be accessible. Lubricate all bearings upon completion of work prior to start-up of the equipment. Lubricants shall be as specified by equipment manufacturers.

3.75 FINAL CLEANING

A. Execute final cleaning prior to final inspection.
B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Clean equipment and fixtures to a sanitary condition.

D. Replace filters of operating equipment.

E. Clean debris from roofs, gutters, downspouts, and drainage systems.

F. Clean site; sweep paved areas, rake clean landscaped surfaces.

G. Remove waste and surplus materials, rubbish, and construction facilities from the site.

3.81 OPERATING INSTRUCTIONS

A. Provide operating instructions as specified in Sections 15050 and 16050.

END OF SECTION
PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Trenching, backfilling, and compacting for mechanical work underground inside the building.

1.14 RELATED SECTIONS

A. Cutting and patching: Section 01731.

B. Piping: Section 15155.

1.20 REFERENCES

A. ASTM D 698: Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbs/cu ft (600 kN-m/cu m)).

1.30 SUBMITTALS

A. General: Submit in accordance with Section 01330.

B. Shop drawings: At the same scale as the contract drawings, showing field verified locations of utilities, and proposed detailed trenching plan.

C. Certifications: Test reports showing that compaction meets specified requirements.

PART 2 - PRODUCTS

2.10 MATERIALS

A. Backfill: Earth materials, free from perceptible amounts of wood, debris, or topsoil, free of frost at the time of placement, and not containing marl or other elements which tend to stay in a plastic state.

2.12 EQUIPMENT

A. Mechanical tampers for compacting backfill: Capable of exerting a blow equal to 250 foot-pounds per square foot of area of the tamping face.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Perform all excavating, trenching, sheeting, shoring, backfilling, and compacting required for the proper installation of the work.

B. Where obstructions are encountered, obtain written approval and make necessary changes in line, grade or location.

C. Protect existing utilities from damage during excavation and backfilling. Repair damaged new or existing work at no addition to the contract sum. Bracing, shoring and other protection of existing utilities is part of this work.
D. Note the depths of footings. In cases where piping or conduit is in close proximity to or below footings and where the natural earth under footings is disturbed, after the line is installed the voids shall be filled up to bottoms of such footings with solid concrete.

3.24 CUTTING

A. Cut concrete with masonry saw prior to breaking it into smaller pieces for removal.

3.25 TRENCHING

A. Excavations inside the building shall be carefully planned. Stockpile excavated earth so as not to interfere with other construction. Dig trenches to the proper depths, providing extra depressions where required for hubs of pipes.

B. Trenches shall be of necessary depth and width for the proper laying of pipe and conduit with a minimum of 8 inches (205 mm) on each side of the joint.

1. The sides shall be as nearly vertical as practicable. Unless local regulations are more strict, trenches 5 ft. (1.5 m) and deeper shall have shored sides as required by OSHA trenching regulations.

2. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for each section of pipe and conduit on undisturbed soil at every point along its entire length, except for bell holes and for the proper sealing of the pipe joints.

3. No greater length of trench shall be left open, in advance of the completed structure placed in it, than can be completed in that day's operation.

4. Except where rock is encountered, do not excavate below the depths required. Where rock excavation is required, excavate to a depth of at least 6 inches (150 mm) below the trench depth and fill the overdepth with compacted crusher run or bank run stone or sand. Unauthorized overdepths in excavation shall be backfilled with crushed stone, slag or gravel, thoroughly compacted.

5. Whenever wet or otherwise unstable soil is encountered, it shall be removed to the depth and extent directed, and the trench backfilled to the proper grade with crushed stone, slag or gravel.

3.26 BACKFILL

A. Place no backfill until the adjacent construction or the utility to be covered has been inspected, tested, and approved.

B. Mechanical systems backfill:

1. Backfill and compact in six-inch layers up to spring line of the pipe. The installations shall then be inspected and tested.

2. Following inspection, backfill in six-inch (150-mm) layers, each compacted, until the pipe has a cover of not less than one foot (305 mm). Place the remainder of the backfill material in the trench in eight-inch (200-mm) compacted layers.

3. Excavations improperly backfilled shall be reopened, then refilled and compacted to the required grade and compaction, and smoothed off.
4. Completed work shall have uniform graded surface, in accordance with the surface and grade indicated on the drawings.

3.27 COMPACTION
   A. Test in accordance with the requirements of ASTM D698.
   B. Compact under slabs to a 95 percent density.
   C. Take particular care in compaction of earth under joints of mechanical piping.

3.41 RESURFACING
   A. Resurface concrete floors as work of this section, matching the construction and finish of adjacent floors.

END OF SECTION
SECTION 07840
FIRESTOPPING

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Through-penetration firestopping in fire-rated construction.
B. Through-penetration smoke-stopping in smoke partitions.

1.14 RELATED SECTIONS

A. Sleeves and plates: Section 15052.
B. Ductwork: Section 15810.
C. Conduit: Section 16131.

1.20 REFERENCES

A. Underwriters Laboratories
   1. UL Fire Resistance Directory
   2. UL 1479: Through Penetration Firestops.
B. American Society for Testing and Materials Standards:

1.21 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described in referenced documents.
B. Barriers: Time-rated fire walls, smoke barrier walls, time-rated ceiling/floor assemblies and structural floors.
C. Construction gaps: Gaps between adjacent sections of walls, exterior walls, at wall tops between top of wall and ceiling, and structural floor or roof decks; and gaps between adjacent sections of structural floors.
D. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.
E. Penetration: Opening or foreign materials passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
F. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.
G. System: Specific products and applications, classified and numbered by the rating agency to close specific barrier penetrations.
1.25 SYSTEM DESCRIPTION

A. Design requirements

1. Fire-rated construction: Maintain barrier and structural floor fire resistant ratings including resistance to cold smoke at all penetrations.

2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations.

1.30 SUBMITTALS

A. General: Comply with Division 1 and Section 01330.

B. Product data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.

2. Manufacturer's installation instructions.

C. Shop drawings: Submit firestop assemblies and devices for all openings and through penetrations in fire-rated construction. Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.

1. Details of each proposed assembly identifying intended products and applicable rating agency classification.

2. Manufacturer or manufacturer's representative shall provide qualified engineering judgements and drawings relating to conditions where rated assemblies do not exist.

D. Quality control submittals:


E. Applicators' qualifications statement:

1. List past projects indicating required experience.

F. Certifications: Letters or forms showing acceptance by local authorities for systems without acceptance by a rating agency.

1.40 QUALITY ASSURANCE

A. Products and assemblies shall be tested and labeled by an independent, nationally recognized testing and labeling authority.

B. Installer's qualification: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, state, or local authority where applicable.

2. At least 2 years experience with systems.

3. Successfully completed at least 5 projects of comparable scale, using these systems.
C. Local and state regulatory requirements: Obtain acceptance for proposed assemblies not conforming to specific rating agency classifications or rated assemblies.

D. Materials shall have been tested to provide fire rating at least equal to that of the construction in which they are to be installed.

1.50 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver products in original unopened packaging with legible manufacturer's identification.
   2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer’s instructions.

1.60 PROJECT CONDITIONS

A. Existing conditions:
   1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
   2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:
   1. Furnish adequate ventilation if using solvent.
   2. Furnish forced-air ventilation during installation if required by manufacturer.
   3. Keep flammable materials away from sparks or flame.
   4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.
   5. Comply with manufacturing recommendations for temperature and humidity conditions before, during and after installation of firestopping.

1.80 WARRANTY

A. General project warranty and correction period, as required in general conditions and Division 1, requires repair or replacement of materials or systems which fail in joint adhesion, co-adhesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer’s data as an inherent quality of the material for the exposure indicated.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Acceptable manufacturers and products: Those listed in the UL Fire Resistance Directory for the UL System involved, or rated for the application by Warnock Hersey or by another acceptable rating agency.

2.20 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Provide systems or devices listed and labeled by a rating agency, and conforming to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance. The system shall be symmetrical for wall applications. Systems or devices shall be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the rated system or device, and designed to perform this function.

2.22 SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.70 ACCESSORIES

A. Fill, void or cavity materials and forming materials: Classified for firestopping use, or included in a rated firestopping assembly, by a rating agency.

PART 3 - EXECUTION

3.02 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.

2. Do not proceed until unsatisfactory conditions have been corrected.

3.05 PREPARATION

A. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.20 INSTALLATION

A. Provide firestop devices or assemblies for every opening and penetration in floors or fire-rated construction.

B. Install penetration seal materials in accordance with printed instructions of the rating agency and in accordance with manufacturer's instruction.

C. Ensure an effective smoke barrier in each sealed penetration. Install smoke stopping as specified for firestopping.
D. Protect materials from damage on surfaces subject to traffic.

E. Where large openings are created in walls or floors to permit installation of pipes, conduits, cables, or other items, close unused portions of opening with firestopping material tested for the application.

3.60 FIELD QUALITY CONTROL

A. Examine penetration seals to ensure proper installation before concealing or enclosing them.

B. Keep areas of work accessible until inspection and acceptance by applicable authorities.

C. Before substantial completion, patch and repair firestopping cut or penetrated by other construction work.

3.70 ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

END OF SECTION
PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Basic material and equipment required for the piping work as indicated on the drawings and
specified in Division 15.

B. Other requirements applicable to more than one section of Division 15.

C. Identification of mechanical systems and equipment.

1.14 RELATED SECTIONS

A. Project and special warranties: Section 01770.

B. Operation and Maintenance Manuals: Section 01770.

C. Painting: Section 09900.

1.21 DEFINITIONS

A. Project correction period: A period after Substantial Completion of the work during which the
Contractor shall correct every part of the work found to be not in accordance with the
requirements of the contract documents, promptly after receipt of written notice.

B. Listing and labeling (third-party certification): Where products and assemblies are required to
be listed or labeled, or both, by an independent, nationally recognized testing and labeling
agency, such agencies, as defined in 29 CFR 1910, shall be recognized by the authority having
jurisdiction and typically include ACIL, ITS, and UL.

C. DN: Dimension Nominale, nominal pipe size in millimeters, in accordance with the metric
system for construction, Systeme Internationale (SI).

D. NPS: Nominal pipe size in inches, in accordance with standard U.S. designations for
manufactured pipe. Pipe sizes do not change when projects are designed and built in metric
units; each size has a consistent name (nominal dimension) in each system.

1.26 DESIGN REQUIREMENTS

A. The drawings and system performances have been designed based on using the particular
manufacturer's products specified and scheduled on the drawings.

B. Products of other manufacturers that are listed under the article "Acceptable Manufacturers", or
permitted as "equal," are permitted provided:

1. Product shall meet the specifications.

2. Contractor shall make, without addition to the contract sum, all adjustments for deviations
so that the final installation is complete and functions as the design basis product is
intended.
C. Do not propose products with dimensions or other characteristics different from the design basis product that render their use impractical, or cause functional fit, access, or connection problems.

D. The contract drawings are generally diagrammatic and do not indicate all fittings or offsets in pipe, all access panels, or other specialties required.
   1. Install pipe exposed to view parallel with the lines of the building and as close to walls, columns, and ceilings as may be practical, maintaining proper clearances for access at all parts requiring servicing.
   2. Install pipe a sufficient distance from other work to permit a clearance of not less than 0.5 inch (15 mm) between its finished covering and adjacent work.
   3. No pipe shall be run below the head of a window or door.
   4. Pull boxes and other appurtenances which require operation or maintenance shall be easily accessible. Do not cut or form handholes for operation or maintenance of appliances through walls or ceilings.

1.30 SUBMITTALS

A. Comply with Section 01330.

B. Shop drawings:
   1. Showing proposed expansion design.
   2. Schedule of welding and brazing procedures proposed for each piping system included in the project.

C. Certifications: Proof of operator and testing agency personnel qualifications as required for welding and brazing in the article "Quality Assurance" below.

D. Test reports: Field test results for each piping system as specified in Part 3 below.

1.40 QUALITY ASSURANCE

A. Provide materials and perform work in accordance with the plumbing, mechanical, electrical, building, fire, health and safety, and other applicable codes and regulations of the state, county or city in which the work is performed.

B. Welding procedures and operator qualifications for structural welding: AWS D1.1, Structural Welding Code Steel, electric arc process.

C. Welding, brazing, and soldering procedures and operator qualifications for building systems piping:
   1. AWS D10.9, Qualification of Welding Procedures and Welders for Piping and Tubing.
   2. ASME B31.9, Building Services Piping.
   3. Copper Development Association "Copper Tube Handbook."

D. Qualifications of independent testing laboratory personnel:
   1. Welding inspectors: AWS QC1, Certification of Welding Inspectors.

E. Electrical control panels, equipment, materials and devices provided or installed as work of
Division 15 shall bear UL label or, if UL label is not available, the item shall be tested and
labeled by a nationally recognized testing agency, acceptable to authorities having jurisdiction,
and in accordance with NFPA 70 (NEC). Provide testing, if required, without addition to the
contract sum.

F. Qualifications of videotape technician: For videotaping specified in "Operating Instructions
(Demonstration)," employ persons skilled in videotape production and editing.

PART 2 - PRODUCTS

2.10 MATERIALS

A. General piping techniques, testing, identification, painting, and operating instructions specified in
this section apply to products specified in other sections of Division 15.

B. Weldolets and thredolets: Fittings designed for installing branches on piping, with either welded
or threaded connection to branch; conforming to ASTM A 234.

C. Solder: Free of lead, antimony, and zinc. No solder containing lead is permitted.

   1. Tin 95.5 percent, copper 4 percent, and silver 0.5 percent; equal to "Silvabrite 100"
      manufactured by Engelhard Corporation.

   2. Tin, copper, bismuth, and silver; equal to "Oatey Silver" manufactured by Oatey.

D. Flux: Meeting requirements of NSF 61.

E. Pipe jointing compound:

   1. Polytetrafluoroethylene (PTFE) pipe thread tape, "Teflon."

   2. Pipe cement and oil.

2.21 IDENTIFICATION DEVICES AND MATERIALS

A. Stenciling materials:

   1. Stencils: Manufactured standard stencils prepared for required applications, conforming to
      ANSI A13.1 for color and size of legend letters, including arrows showing direction of flow.

   2. Paint: Exterior type enamel, colors conforming to ANSI A13.1, or black.

B. Equipment identification tags:

   1. Laminated plastic with white core and black outer layers, which, when engraved, will
      produce white letters and numerals on a black background.
2. Tags installed on curved surfaces shall be aluminum or brass.

C. Valve tags: Brass, 1.5 inch (40 mm) in diameter with black-filled numbers not less than 0.25 inch (6 mm) high, complete with brass attachment chains.

2.23 DATE-SENSITIVE EQUIPMENT

A. Date-sensitive equipment: Systems, equipment, or components which use or process date and time data in order to perform their functions.

B. Each item of date-sensitive equipment used in the project shall be warranted by the manufacturer to properly function and correctly use or process all time-related data for all dates and times which occur during a reasonable life expectancy of the equipment.

PART 3 - EXECUTION

3.03 INSTALLATION OF PRODUCTS AND EQUIPMENT

A. Manufacturer’s instructions: Except as modified by drawings or specifications, install products and equipment in accordance with manufacturer’s instructions and recommendations applicable to the project conditions.

1. Immediately notify Engineer if a difference or discrepancy is found between manufacturer’s instructions and the drawings or specifications.

3.22 PIPE INSTALLATION

A. Remove burrs resulting from cutting pipe or from any other operation.

B. Threaded connections:

1. Cut threads full and clean.

2. Apply specified pipe jointing compound or tape on male threads only.

C. Thoroughly clean pipe and fittings before they are installed, and keep them clean until the acceptance of the completed work. Cap or plug the ends of the lines so as to prevent earth and other debris from entering during construction.

D. Provide for expansion and contraction of piping and connections so that no strain or breakage will occur. Provide anchors and guides of approved design where shown on drawings and where necessary to allow for proper expansion and contraction. At the time of installation, expansion loops shall be cold sprung to one-half of the calculated expansion.

E. Provide for draining all parts of water piping systems and apparatus by installing a valved hose connection at every low point.

F. Black steel piping NPS 2.5 (DN 65) and larger shall be welded; NPS 2 (DN 50) and smaller shall be threaded, except as required otherwise in a particular section.

G. Do not weld galvanized piping.

H. Use welding fittings, tees, wyes, reducers, eccentric reducers, and caps as required. Branches at least two nominal pipe sizes less than the main may be made with “Weldolets” or
"Thredolets" installed with full size opening in larger pipe and in accordance with manufacturer's printed instructions. Flanges shall be welded neck or slip-on pattern of class to suit the valves or equipment connections. Flanges shall have machine bolts with hex nuts and washers.

I. Each connection from risers to equipment shall contain at least three elbows or expansion joints. Connections shall be so arranged that movement in piping due to expansion and contraction will not be transmitted to the equipment.

J. Install unions and flanges in the piping at each item of equipment, control valve, and appliance, so as to provide easy removal of the equipment, valve, or appliance, and to provide for easy removal of coils.

K. Pitch water piping so that air in the system can be properly vented. Provide stop valves where necessary to isolate parts of system for repairs without draining the entire system.

3.23 COPPER TUBING FOR WATER INSTALLATION

A. Solder joints for copper tubing: Clean ends of tubing and inside of fitting ends thoroughly with emery cloth before applying flux.

B. Make flare joints in copper tubing with proper size flaring tool and in accordance with manufacturer's recommendations.

C. Provide isolation fittings between copper and steel piping to prevent electrolysis.

D. Cut pipe with a tubing cutter or fine-tooth saw. Cuts made with a saw shall be true and square, and the end shall be filed smooth with a fine-tooth file. Remove all marks and burrs with sandpaper.

3.25 INTERFACE WITH OTHER PRODUCTS

A. Where it is necessary to run pipes through walls, provide finished, permanent, waterproof installation complete with inserts, sleeves, supports or hangers, seals, and other appurtenances as required. Do not pierce, cut, or notch any footing or other structural member.

B. Waterproofing and dampproofing of the building shall be unharmed by the installation of the work. Where pipe has to pierce waterproofing or dampproofing, including outside walls, the penetration shall be made watertight. Waterproofing damaged or destroyed shall be repaired or replaced with new waterproofing.

3.59 IDENTIFICATION

A. General: Do not apply identification until insulation and finish painting work is complete.

B. Equipment:

1. Stencil equipment with minimum two-inch (50-mm) -high letters or provide identification tags. Clearly identify function, equipment served, and area served.

2. Firmly fasten each identification tag to its appropriate piece of equipment with drive screws, sheet metal screws, or rivets. Do not interfere with operation of, or damage the item being marked.

C. Piping:
1. Mark by stenciling.

2. Mark to identify service with arrows showing direction of flow. Apply markings near building walls where pipes enter or leave an accessible space and in intermediate locations so that markings are no more than 30 feet (9 m) apart. They shall be readily visible to a person standing on the floor.

3. Fully identify all piping installed as work of the project.

4. Mark pipe with letters of height and with colors as required by OSHA and conforming to ANSI A13.1.

5. Identify every thermometer, gauge, and control device.

6. Provide valve tags for all valves except stop valves on individual fixtures or equipment where their function is obvious, or where the fixture or equipment is immediately adjacent. Numbers shall correspond to those shown on the Valve Chart. Attach tags to valve shaft.

D. Stencil ductwork after insulation is applied, if required, with minimum two-inch (50-mm)-high letters, clearly identifying service (supply, return, exhaust) and showing direction of flow with arrows. Mark ducts near the building walls where they enter or leave a space, and at intervals of not more than 30 feet (9 m). Identification shall be visible to a person standing on the floor.

3.61 PIPING TESTS

A. Notify Owner at least one day prior to the actual test.

B. Test before pipes are concealed or insulated. Test the piping in sections as the work progresses, so as not to delay progress of the building construction. Furnish pumps and gauges required for testing.

C. Conduct piping tests before connecting equipment that would be subject to damage from the test pressure. Replace piping or fittings found defective with new material.

D. Bracing and supporting: Adequately brace and support piping during the test, so that no movement, displacement, or damage results from the application of the test pressure.

E. Interior sanitary and storm drainage piping:

1. Before connection of the plumbing fixtures and before connection to the sewer, cap or plug the entire sanitary, condensate, and storm drainage piping systems of the building.

2. Test following the methods of testing required by the National Standard Plumbing Code, and no less than the duration and pressures required in the Schedule of Piping Systems Tests.

3. Where pipes are in trenches, leave the trenches open until the completion of the test.

F. Test the piping systems for not less than four hours to fulfill the conditions in the Piping Systems Test Schedule at the end of this section.
G. Documentation of tests: Prepare a test report for each portion of piping tested, identified by service, material, location, and pipe size. Include these items:

1. Date of test.
2. Starting and completion times.
3. Initial test pressure.
4. Final test pressure.
5. Problems or leaks detected.
6. Corrective actions taken.
7. Record of successful completion of testing.
8. Name, title, and signature of person conducting test.

3.75 CLEANING AND PAINTING

A. Cleaning: Clean all piping and equipment. Where items are to be painted, clean ready for painting.

B. Painting: Coordinate painting with requirements of Division 9. Paint the items identified below to be painted. Use paint materials and systems specified in Division 9.

C. Items to be painted:
   1. Items identified below to have protective coating.
   2. Items furnished with manufacturer’s prime coat.
   3. Piping and ductwork exposed in finished spaces, insulated and uninsulated.
   4. Inside ducts behind registers, grilles, and diffusers.

D. Items not to be painted: Copper, stainless steel, and equipment furnished with manufacturer’s finish.

E. Paint systems for exposed piping and ductwork: Primer compatible with the substrate, whether steel, galvanized steel, insulation jacket, or other material; one coat or two, if required to cover, to match adjacent surfaces in color and texture.

F. Painting inside ducts behind registers, grilles, and diffusers: Matte black, compatible with substrate and suitable for the temperatures at which the duct will operate, extending from the duct opening to a depth such that no unpainted surface will be visible to a person standing on the floor or adjacent balconies.

3.81 OPERATING INSTRUCTIONS (DEMONSTRATION)

A. Furnish the necessary technicians, skilled workers, and helpers to operate all the mechanical systems and equipment of the entire project for one 8-hour day.
B. Where specified in technical sections, provide longer periods required for specialized equipment.

C. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of all systems and equipment.

D. The Operating and Maintenance Manual shall be available at the time of the instructions, for use by instructors and Owner personnel.

E. Videotape each instruction session, including both the sessions specified above and added sessions required in technical sections for specialized equipment. Provide one complete set of videotapes with each Operating and Maintenance Manual.

F. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

3.90 SCHEDULES

A. Piping Systems Test Schedule:

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>TEST PRESSURE PSIG (kPa)</th>
<th>ALLOWABLE DROP</th>
<th>MEDIUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic water, cold &amp; hot, and recirculated</td>
<td>125 (860)</td>
<td>None</td>
<td>Water</td>
</tr>
<tr>
<td>Heating water</td>
<td>125 (860)</td>
<td>None</td>
<td>Water</td>
</tr>
<tr>
<td>Chilled water</td>
<td>125 (860)</td>
<td>None</td>
<td>Water</td>
</tr>
<tr>
<td>Air conditioning condensate drain</td>
<td>4.3 (30)</td>
<td>None</td>
<td>Water</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 15052
SLEEVES AND PLATES

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Sleeves and escutcheon plates for piping systems.
B. Mechanical seals for piping penetrations.

1.30 SUBMITTALS

A. General: Comply with Division 1 and Section 15010.
B. Product data: Sleeves, plates, sealants, and mechanical penetration seals.

PART 2 - PRODUCTS

2.10 SLEEVES, PLATES, AND ACCESSORIES

A. Steel sleeves: Schedule 40 black steel pipe, ASTM A 53.
B. Copper sleeves: Type L, ASTM B 88 hard drawn.
C. Cast-iron sleeves: Extra heavy, equal to product of U.S. Pipe Co. with waterstop and ends as shown on the drawings.
D. Sealing compound in walls and floors: Equal to the following:
   1. Bare and insulated pipes carrying fluids 150 degrees F (65 degrees C) and below: Sika Corporation "Sikaflex - la."
   2. Bare and insulated piping carrying fluids 151 degrees F (66 degrees C) and above: Dow Corning Corporation "790 Silicone."
E. Floor, wall and ceiling plates: Stamped or cast brass, hinged type equal to Beaton and Caldwell Mfg. Co., Nos. 11, 40, 3A, and 36 as pipe size requires. Plates shall have chrome finish.
F. Mechanical penetration seals: Equal to Thunderline Corporation "Link-Seal 400 Series Hydro-Static Pipe Wall Closure" or Calpico Sealing Link "LIXN". Seals shall be modular mechanical type, consisting of interlocking synthetic links shaped to continuously fill the annular space between the pipe and wall opening. Bolt and nut fasteners for the seals shall be stainless steel for units used in penetrations below grade.

PART 3 - EXECUTION

3.20 INSTALLING SLEEVES

A. Install sleeves for piping, or piping with insulation continuous through sleeve, passing through walls, partitions, beams, or slabs.
   1. Exception: Where steel pipe penetrates a steel beam that is not part of a fire- or smoke-rated assembly, no sleeve is required.
B. Do not cut, drill, or burn structural steel for installation of piping without specific instructions from the Owner.

C. Locations in nonfire-rated construction:
   1. Install steel sleeves for penetrations of steel, iron, and insulated piping.
   2. Install copper sleeves for penetrations of uninsulated copper tubing and piping.

D. Locations in floors and fire-rated construction: Sleeves used in piping penetrations through fire-rated construction shall be an acceptable component of the through-penetration firestop assembly as specified in Section 07840 Firestopping.
   1. Where firestop assembly is UL listed, sleeve material shall be as directed in the listing.
   2. Where other specified approval and acceptance is required, sleeve shall be as described in the approved assembly.

E. Install sleeves through walls and partitions flush with finished surfaces.

F. Sleeves through floors shall extend 0.375 inch (10 mm) above top of finished floor and be finished neat and level. Sleeves through mechanical or equipment room floors shall extend one inch (25 mm) above finished floor. Provide projecting sleeves with anchor clips to prevent them from being loosened and knocked down in the floor construction.

G. Sleeves for insulated piping with vapor barrier shall be large enough to pass piping and insulation.

H. Seal spaces between sleeves and pipe, or pipe insulation, in nonrated walls, with mineral wool.

I. Penetrations in exterior masonry or concrete walls and foundations:
   1. Sleeves: Cast iron, or in cast concrete may be core drilled.
   2. Above grade: Oakum and lead, or mechanical penetration seal, at outside face of wall.
   3. Below grade: Mechanical penetration seals at outside and inside faces of wall.

3.25 INSTALLING PLATES

A. Piping passing through interior walls, partitions, floors, and ceilings in exposed locations shall be fitted with wall, floor, and ceiling plates of size and depth to conceal sleeves. Secure plates firmly in place with set screws.

END OF SECTION
PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Unless otherwise specified in a particular section or required for a particular application, motors shall conform to the following requirements, whether factory-installed or field-installed.

1.13 PRODUCT FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Motor capacitors: Section 16150, Wiring Connections.

1.14 RELATED WORK SPECIFIED ELSEWHERE

A. Pumps: Sections 15441 and 15705.

B. Air-handling units: Section 15721.

C. Fans: Section 15830.

1.20 REFERENCES

A. NEMA MG 1: Motors and Generators.


D. UL 508: Industrial Control Equipment.

1.21 DEFINITIONS

A. Energy efficient motor: Motor meeting the nominal and minimum efficiency levels listed for its horsepower and speed in Table 12-10 of NEMA MG 1.

B. Nominal efficiency: Efficiency as defined in Table 12-8, Efficiency Levels, in NEMA MG 1, and identified on the motor nameplate.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data:

1. Motors and drives not provided with equipment: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lugs, and coatings.


C. Wiring diagrams required for the proper installation of mechanical equipment.
D. Submit product data which verifies compliance with ASHRAE 90.1 or provide certified performance ratings by a qualified independent testing agency.

E. Certifications:
   1. Actual motor power factor for each motor, certified test results for each motor proposed for use on this project.
   2. Field test showing corrected power factor, if required.
   3. Motors controlled by variable frequency controllers: Certification that motor meets specified requirements.
   4. Certified report of factory start-up test of each variable frequency drive, copy of report maintained on file by the manufacturer.

F. Warranty for variable frequency drive, executed and signed at the time of putting the controller in service.

1.40 QUALITY ASSURANCE

A. Actual motor power factor shall be tested and certified by an independent testing laboratory.

B. Where power factor is field tested as required in "Power Factor" in Part 2 below, specialist performing tests shall be acceptable to the local authorities having jurisdiction.

C. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical Materials and Methods.

D. HVAC equipment shall meet the energy performance requirements of ASHRAE 90.1.

1.42 QUALIFICATIONS OF VARIABLE FREQUENCY DRIVE INSTALLER

A. Authorized, and staff factory trained, by manufacturer.

B. Maintains in the Baltimore/Washington, DC, metropolitan area a service center with staff factory trained by manufacturer.

C. Offers 24-hour, seven-day emergency service.

D. Maintains locally an adequate stock of manufacturer's genuine or approved parts to service this equipment.

1.44 REGULATORY REQUIREMENTS

A. Motors shall conform to the requirements of NEMA MG1 and applicable portions of the National Electric Code (NEC, NFPA 70).

1.80 WARRANTY

A. In addition to the general project warranty, provide for the variable frequency drive (VFD) a special project warranty from the supplier, covering replacement, parts, and labor, for two years from the date of startup.
PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Motors:

- Baldor Electric Co.
- MagneTek
- Marathon
- Reliance
- Siemens
- Toshiba International

B. Motor capacitors:

- General Electric
- Sprague
- Westinghouse

C. Variable frequency drives:

- ABB Power Distribution
- Baldor Electric Co. (Graham)
- Magnetek
- Omron IDM Controls
- Reliance
- Square D Co.
- Toshiba International

2.20 BASIC MOTOR REQUIREMENTS

A. Capacity: Each motor shall have sufficient capacity and torque to start, accelerate, and operate the machine it drives without exceeding the motor nameplate rating at the speed specified, or at any speed and load which may be obtained by the drive actually furnished.

B. Starting: Each automatically controlled motor shall be capable of starting as frequently as the control sequence may demand. Motors not automatically controlled shall be capable of making no fewer than 4 starts per hour.

C. Loads: Belt-connected motors shall be equipped with shafts and bearings designed to withstand both the normal connected loads of the drive furnished, and momentary loads imposed during acceleration.

D. Ratings: Motors shall be rated for continuous duty at 100 percent of rated capacity, and temperature rise shall be based on ambient temperature of 40 degrees C.

E. Phase: Unless otherwise indicated, motors one-half horsepower and larger shall be polyphase and motors smaller than one-half horsepower shall be single-phase motors.

F. Motor construction:

1. Motors for fans, air handling units, and pumps, unless specified otherwise in the equipment section, shall be open drip-proof NEMA design B construction.
G. Efficiency: The term "energy efficient" is defined in the article "Definitions" in Part 1 above.

1. Single-phase motors, alternating-current fractional horsepower, rated 1/20 to 1 horsepower, 250 volts or less: NEMA MG 11, types and efficiencies selected for their applications.

2. Polyphase motors, medium alternating-current, squirrel-cage, 1 to 500 horsepower, 600 volts or less: NEMA MG 10, energy-efficient types selected for their application. Nominal full-load efficiencies shall meet or exceed ratings of Table 12-10 of NEMA MG 1.

2.21 SINGLE-PHASE MOTORS

A. Permanent split-capacitor or split-phase type.

B. Bearings: Sealed, prelubricated ball-bearing type.

2.22 POLYPHASE MOTORS

A. NEMA MG1 Design B.

B. Stator: Copper windings.

C. Rotor: Squirrel cage.

D. Bearings: Doubly shielded, prelubricated ball bearings suitable for radial and thrust loading of connected equipment.

E. Temperature rise shall not exceed insulation rating.

F. Insulation: Class F.

G. Motors used with inrush controllers: Match wiring requirements for indicated controller with required motor leads brought to motor terminal box to suit control method.


I. Motor frame and endshields: Cast iron.

J. Conduit box: Either steel or aluminum, diagonally split and rotatable in 90-degree increments, with grounding provision.

K. Finishes:

1. External hardware: Plated to resist corrosion.

2. External paint: Industrial enamel.

L. Nameplates: Stainless steel or aluminum, and stamped in accordance with NEMA MG1. Nameplate information shall include the nominal efficiency value in accordance with NEMA MG1 and the manufacturer’s minimum guaranteed efficiency value.

2.24 MOTORS CONTROLLED BY VARIABLE FREQUENCY DRIVES
A. Specifically constructed and warranted by the manufacturer to meet the voltage requirements of NEMA MG 1, Part 31.4.4.2.

B. Temperature rise: Match rating for Class B insulation.

C. Insulation: Class F (ODP).

2.25 POWER FACTOR

A. Power factor for three-phase motors 10 HP and larger shall be not less than 90 percent at full rated load. Test, certify, and submit certified reports for each motor as required in "Submittals" and "Quality Assurance" in Part 1 above.

1. Should the Contractor propose to provide motors with less than 90 percent power factor, provide power-factor-correcting, automatically discharging type motor capacitors. The corrected power factor of the motor-capacitor combination shall be equal to or greater than 90 percent. Submit certified test results.

2. Motor capacitor: Designed for installation at the load side of motor starters; insulated, impregnated component unit completely enclosed in a grounded steel case with welded and ground seams. Where installed on outdoor equipment, case shall be weatherproof. Provide each unit with a flexible cable for connection to the starter or motor terminals. The capacitor shall be suitable for use in areas with ambient temperatures ranging from minus 10 degrees F to 115 degrees F.

2.26 MOTOR DRIVES

A. Motors for belt-driven units shall have adjustable variably pitched cast-iron sheaves to allow a 10 percent increase or reduction in speed. Belts shall be sized for minimum 150 percent BHP. Provide OSHA- and MOSHA-approved type belt guards. Include one change in drive sheave for each unit if necessary to obtain required air quantities and static pressure.

2.27 VARIABLE FREQUENCY DRIVES (ADJUSTABLE FREQUENCY DRIVES)

A. Adjustable-frequency alternating-current motor drive consisting of a diode-bridge rectifier and a pulse-width modulated (PWM) inverter for use on a standard NEMA Design B induction motor. The drive shall be designed specifically for variable torque HVAC applications.

1. The variable frequency drive (VFD) shall be solid state, with a pulse-width modulated (PWM) sine-coded output waveform. The VFD shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier to prevent input line notching, built-in ac line reactor or dc link reactor, and insulated-gate bipolar transistors (IGBTs) as output power switching devices. Audible noise from motor and VFD shall not be increased more than two dB, over motor running alone, at one meter, above across-the-line power.

2. Listed and labeled as a complete unit under UL 508 C.

3. Input 460 Vac +/-10%, 3-phase, 48-63 Hz.

4. Output 0 - Input Voltage, 3-phase, 0 to 60 Hz.

5. Environmental operating conditions: 0 to 40 degrees C, 0 to 3300 feet above sea level, less than 95 percent humidity, non-condensing.
The VFD shall include the following features, all factory mounted and wired within the VFD enclosure:

1. The same customer interface, including digital display, keypad and customer connections. The keypad is to be used for local control (start/stop, forward/reverse, and speed adjust), for setting all parameters, and for stepping through the display and menus.

2. Printed circuit boards shall be completely tested and burned-in before being assembled into the completed VFD. The VFD shall then be subjected to a preliminary functional test, eight hour burn-in, and computerized final test. The burn-in shall be at least 104 degrees F (40 degrees C), at full rated load, or cycled load. Drive input power shall be continuously cycled for maximum stress and thermal variation.

3. Control of harmonics: 3 percent input reactor, ac line or dc link type.

4. A minimum carrier frequency of 3 kHz, field adjustable up to 8 kHz without the need to derate the drive when frequency is increased.

5. Three-phase EMI/RFI filter capable of filtering out unwanted radio frequency interference (RFI) in the range of 10 kHz to 30 MHZ.
   a. Manufacturer's option: If the drive does not contain a factory-mounted RFI filter, manufacturer shall submit with product data required in Part 1 above a written guarantee that if RFI should occur, the manufacturer will provide engineering analysis and correct the problem to the Owner's satisfaction, including providing RFI filters if required, at no addition to the contract sum.

6. Prewired 3-position Hand-Off-Auto switch or keypad.

7. Three programmable preset speeds.

8. Two independently adjustable accel and decel ramps, times adjustable from 1 to 360 seconds.

9. Two programmable analog inputs shall accept a current or voltage signal for speed reference. Analog inputs shall include a filter programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20 mA and 0-10 Volts.

10. Six programmable digital inputs for maximum flexibility in interfacing with energy management systems, including run, stop, fault, and three preset speeds.

11. Two programmable analog outputs proportional to motor speed, output voltage, or output current.

12. Two programmable digital relay outputs for "run" and "fault" status. The relays shall be rated for maximum switching current 8 amps at 24 Vdc and 0.4 amps at 250 Vac; Maximum voltage 300 Vdc and 250 Vac; Continuous current rating 2 amps rms.

13. Provide a separate terminal strip for connection of freeze, fire, and smoke contacts, and external start commands. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in Hand, Auto or Bypass.
14. Bypass consisting of manual transfer with service switch to line power via contactors. Bypass shall be UL listed, and drive and bypass shall be combination tested for at least 22 KAIC series rating. Include motor thermal overload and fuse or circuit-breaker protection while in bypass operation. A three-position selector switch to control the bypass contactor and the drive output contactor is to be mounted on the enclosure door. When in the "normal" mode, the bypass contactor is open and the drive output contactor is closed. In the "test" position both contactors are open, and in the "bypass" position, the drive output contactor is open, and the bypass contactor is closed. The drive output contactor shall also be open when a stop command is given, isolating the motor from the drive. Start/stop signals and safety interlocks will work in drive and bypass modes.

C. The VFD shall include the following functions, all either pre-programmed or field programmed with the Owner's requirements by a factory trained representative:

1. The ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip.

2. Capability of starting into a rotating load (forward or reverse) and accelerating or decelerating to setpoint without safety tripping or component damage (flying start).

3. Equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia.

4. The VFD shall run at a programmable preset speed if the input reference (4-20mA or 2-10V) is lost.

5. Three programmable critical-frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.

6. The VFD shall ramp or coast to a stop, as selected by the user.

D. The VFD shall include the following electrical protection and safety devices, all factory mounted and wired within the VFD enclosure:

1. The VFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition.

   a. Overcurrent trip 200 percent of the VFD's variable torque current rating.
   b. Overvoltage trip 130 percent the VFD's rated voltage.
   c. Undervoltage trip 60 percent of the VFD's rated voltage.
   d. Overtemperature +70 degrees C.
   e. Ground fault
   f. Adaptable electronic motor overload (I^2t): The electronic motor overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which protect the motor only at full speed are unacceptable.

2. The VFD shall employ three current limit circuits to provide trip-free operation;
a. The slow current regulation limit circuits shall be adjustable from 50 percent to 110 percent of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.

b. The rapid current regulation limit shall be fixed at 140 percent of the VFD's variable torque current rating.

c. The current switch-off limit shall be fixed at 150 percent of the VFD's variable torque current rating.

d. The overload rating of the drive shall be 110 percent of its variable torque current rating for 1 minute every 10 minutes, and 115 percent of its variable torque current rating for 2 seconds every 10 seconds.

3. Fuses shall be 200 KAIC current-limiting type in the drive enclosures.

4. Magnetic circuit breaker, interlocked with the door, which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be through-the-door type, and be padlockable in the Off position.

5. A Class 20 bimetallic thermal motor overload relay shall be provided to protect the motor in bypass.

6. The terminal strip shall be isolated from the line and ground.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Mount direct-connected motors securely and in accurate alignment. The drive shall be free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

B. Provide each belt-connected motor with a securely mounted adjustable base to permit installation and adjustment of belts.

C. Mount capacitors shipped separately beside motor connection box as required. Connect in accordance with the requirements of Division 16, Electrical.

   1. Test units at full rated load after the installation of the motor capacitors, and submit reports.

D. Provide additional drive and belt changes where required to meet requirements of testing and balancing specified in Section 15950, Testing, Adjusting and Balancing.

3.21 INSTALLING VARIABLE FREQUENCY DRIVE

A. Install drives in locations shown on drawings.

B. Install wiring between drive and motor in ferrous metal conduit, with separate conduits for power input, power output, and controls.

   1. Minimum separation between conduits: 3 inches.
C. Service engineers trained and authorized by the variable-frequency drive manufacturer at the service center shall provide start-up service, including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

3.81 OPERATING INSTRUCTIONS

A. As specified in Section 15050, provide operating instructions.

B. Provide at least four consecutive hours of additional instruction time for the variable frequency drive.

END OF SECTION
SECTION 15055
MECHANICAL DEMOLITION

PART 1 - GENERAL

1.11 SECTION INCLUDES
   A. Extent and location of demolition are shown on the drawings.

1.14 RELATED SECTIONS
   A. Demolition: Section 01732.

1.20 REFERENCES

1.40 QUALITY ASSURANCE
   A. Demolition shall be carried out as expeditiously as possible in accordance with accepted practice and applicable building code provisions.

1.60 PROJECT CONDITIONS
   A. If, in the course of the work, workers encounter a material they suspect to be asbestos, to contain lead or PCBs, or to present some other hazard:
      1. Promptly notify the Owner and Engineer in writing.
      2. Do not perform any work which would disturb the suspected material until written instructions have been received.
   B. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
   C. Locate, identify, and protect mechanical and electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.05 PREPARATION
   A. Before beginning to remove equipment which contains refrigerants, remove refrigerants.
      1. Following the recommendations of ASHRAE 3 and requirements of local authorities having jurisdiction, and using approved equipment, recover refrigerants.
2. Store each type of refrigerant in a separate container which meets requirements for refillability.

3. Handle and store following the recommendations of ASHRAE 3.

3.20 DEMOLITION

A. Comply with demolition and disposal requirements of Division 1.

B. Perform removal work neatly with the least possible disturbance to the building.

C. Provide temporary barriers, danger signals, and appurtenances for protection of personnel and equipment during removal operations.

D. Demolish, remove, demount, and disconnect inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.
   1. Piping and ducts embedded in floors, walls, and ceilings may be abandoned in place if they do not interfere with new installations. Cut back to at least one inch below finished surface.

2. Remove materials above accessible ceilings.

3. Drain and cap items to remain behind finished surfaces.

4. Patch and repair surface materials as required in Section 01731, Cutting and Patching.

E. Remove anchors, bolts, and fasteners associated with piping and equipment to be removed.

3.22 DISPOSAL

A. Dispose of equipment and materials removed, and rubbish and waste material, as work progresses. Do not allow demolition debris to accumulate on site. Remove products of demolition from the building daily.

3.23 PROTECTION

A. Provide adequate and positive protection to existing building and equipment that is to remain, particularly to prevent entry of either dust or water. Assure weathertightness at all times. Keep standby patching materials on hand to patch and maintain protection as required.

END OF SECTION
SECTION 15060
HANGERS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Supports for piping systems and equipment.
B. Equipment bases.
C. Pipe guides and anchors.
D. Accessories.

1.14 RELATED SECTIONS

A. Vibration control supports: Section 15070.
B. Duct supports: Section 15810.

1.20 REFERENCES

A. ASME B31.9: Building Services Piping.
C. MSS SP-69: Pipe Hangers and Supports - Selection and Application.

1.21 DEFINITIONS

A. Definitions are from MSS SP-69, "Classification of Piping Systems."
B. Hot Systems: Maximum operating (service) temperatures 120 degrees F (49 degrees C) and above.
C. Ambient Systems: Maximum operating temperatures 60 to 119 degrees F (16 to 48 degrees C).
D. Cold Systems: Maximum operating temperatures 59 degrees F (15 degrees C) and below.

1.30 SUBMITTALS

A. General: Comply with Section 01330.
B. Product data: Provide manufacturer's literature showing compliance with specifications for each type of hanger, manufactured support, guide, and anchor, including fasteners and accessory materials.

1.40 QUALITY ASSURANCE

A. Hangers, supports, guides, and anchors shall comply with the requirements of:
1. MSS SP-58.
2. ASME B31.9.

B. Installation of hangers, supports, guides, and anchors shall comply with MSS SP-69.

C. Qualifications of welders: As specified in Section 15050, Basic Mechanical Materials and Methods.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Hangers

Grinnell Supply Sales Company
Carpenter and Paterson, Inc.
PHD Manufacturing, Inc.

B. Support systems

Grinnell Supply Sales Company
Unistrut
PHD Manufacturing, Inc.

C. Thermal hanger shields

Carpenter and Patterson, Inc.
Pipe Shields, Inc.
Rilco Manufacturing Co., Inc.

D. Pipe guides

Adsco
Carpenter and Paterson, Inc.
Metraflex Company

E. Anchors

Carpenter and Paterson, Inc.
Metraflex Company

2.10 CONCRETE

A. Concrete shall be no less than 3000-lb (25,000 kPa) strength.

B. Reinforcement: 6 by 6 inch (150 by 150 mm) welded steel wire fabric, ASTM A 185.

2.11 GROUT

A. Non-shrink grout: Premixed, consisting of non-metallic aggregate, cement, and water-reducing and plasticizing agents; capable of developing minimum compressive strength of 7,000 psi (48,000 kPa) in 28 days.
2.20 HANGERS AND SUPPORTS

A. Types are identified by MSS type numbers in the article "Installing Pipe Hangers and Supports" below.

B. Materials for hangers and clamps:
   1. For steel, insulated, and cast-iron pipe: galvanized or factory-painted.

C. Materials, insulating:
   1. Calcium silicate, high-density, 100 psi (60 kPa) minimum compressive strength, free of asbestos, water-repellant-treated.
   2. For structural insulation inserts, the same, except minimum compressive strength 600 psi (4140 kPa).

D. Protection shields for use where insulation on piping is continuous through hanger or support:
   1. Pipe covering protection shield: Metal of the length and minimum gauge recommended by manufacturer for pipe size. Where the span between hangers is greater than ten feet (3 m), and where the supports are pipe rollers, provide two layers of sheet metal in the shield.
   2. Structural insulation insert: Calcium silicate, same thickness under load as adjacent pipe insulation. Where insulation includes vapor barrier, insert shall extend one inch (25 mm) beyond sheet metal shield for making sealed vapor barrier joint.
   3. Thermal hanger shields: Manufactured support assemblies provided complete with calcium silicate structural insulation inserts, same thickness as adjoining insulation with vapor barrier and encased in 360-degree galvanized steel shield.

E. Pipe covering protection saddle: Steel, meeting requirements of MSS SP-58 Type 39, with calcium silicate insulation in the space between saddle and pipe.

F. Hanger rod nuts and washers shall be zinc-plated. Hanger rods shall be solid steel, all threaded, and zinc-plated.

G. Channel: Slotted cold-rolled steel, equal to Grinnell PS 150 S, 12 gauge with 0.406- by 3-inch (10 by 76-mm) slots on 4-inch (102-mm) centers.

H. Wall- and floor-mounted supports: Structural support system equal to Grinnell "Power Strut."

I. Structural shapes: ASTM A 36.

J. Steel pipe: ASTM A 53, standard weight.

K. Threaded rod: MSS SP-58.

2.22 FASTENERS
A. **Fasteners to concrete:** Self-drilling type expansion shields or machine bolt drop-in anchors for drilled holes, equal to ITT Phillips Anchors "Red Head." Fasteners to ceilings shall be vibration and shock resistant. Load applied to fasteners shall not exceed 25 percent of manufacturer's stated load capacity in 3500 psi (24,000 kPa) concrete.

B. **Fasteners to drywall or cavity wall construction:** Equal to ITT Phillips Anchors "Red Head" toggle bolts, with hollow wall drive anchors or nylon anchors as required.

C. **Bolts, nuts, and washers:** ASTM A 307, or ASTM A 325 where high strength is required.

### 2.23 PIPE GUIDES

A. **Pipe alignment guides shall be equal to Carpenter and Paterson Figure 1007 heavy-duty insulating type, consisting of a spider and a housing sleeve, constructed of minimum 0.375-inch-thick (9.5-mm) steel.**

### 2.24 PIPE ANCHORS

A. **Anchors shall be fabricated from structural steel conforming to ASTM A 36 as detailed on the drawings; shall conform to applicable ASME codes; and shall be capable of withstanding the forces imposed by the system on anchor points.**

B. **Anchor pipe shoes:** Gusseted, equal to Carpenter and Paterson Figure 1120.

### PART 3 - EXECUTION

#### 3.20 INSTALLING PIPE HANGERS AND SUPPORTS

A. **Types and locations (Type numbers refer to MSS SP-58 and systems refer to SP-69 definitions in Part 1 above):**

   **Type 1** Clevis hanger:
   1. Non-steam Hot Systems NPS 0.5 through NPS 8 (DN 200).
   2. Ambient Systems and Cold Systems of all sizes.

   **Type 8** Riser clamp, steel for steel or cast-iron risers and stacks, copper plated for copper risers and stacks.

   **Type 18** Malleable iron concrete inserts for supporting hangers from concrete structure.

   **Type 20** Side beam clamp for attaching hanger rods to structural beams. Use proper size clamp to suit beam flange.

   **Type 23** C clamp for beams with maximum flange thickness of 0.75 inch (19 mm); for use with single pipes NPS 2 (DN 50) and smaller.

   **Type 33** Heavy welded steel bracket capable of supporting up to 3,000 lbs (1360 kg), with a Type 9 or Type 1 hanger, for piping along walls.

   **Type 37** Adjustable pipe stanchion saddle with U-bolt and floor flange anchored to floor, for piping NPS 2 to 12 (DN 50 to 300) supported from floor.
Type 39  Pipe-covering protection saddle for use between roller-type hangers and Hot System piping.

Type 40  Pipe-covering protection shield of proper size to fit insulation, between hanger and insulation:

1. Include structural insulation insert between protection shield and pipe for piping NPS 2.5 (DN 65) and larger.

2. Option: Instead of protection shield and structural insert, provide thermal hanger shield. For piping NPS 4 (DN 100) and larger on rollers, include steel weight distribution plate.

Type 44  Cast-iron roll, steel roll rod, provided with steel chair, bolts, and hex nuts, for pipe in racks and at fixed structural supports such as brackets, where no vertical adjustment is required.

B. Trapeze piping supports:

1. Field-fabricated from ASTM A 36 steel shapes.

2. Weld steel according to AWS D-1.1.

3. Size threaded rods in accordance with MSS SP-58.

4. Design trapeze support assembly based on supported load plus a 50 percent safety factor.

C. For hangers requiring vibration control, see Section 15070.

D. Hanger rod sizes:

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>ROD SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPS (DN)</td>
<td>Inches (mm)</td>
</tr>
<tr>
<td>Up to 2 (Up to 50)</td>
<td>0.375 (10)</td>
</tr>
<tr>
<td>2.5 to 3.5 (65 to 90)</td>
<td>0.5 (15)</td>
</tr>
<tr>
<td>4 and 5 (100 to 125)</td>
<td>0.625 (16)</td>
</tr>
<tr>
<td>6 and 8 (150 to 200)</td>
<td>0.75 (20)</td>
</tr>
</tbody>
</table>

E. Horizontal piping generally shall be supported from above.

1. Attaching to walls: Use two 0.375-inch (9.5-mm) screw-type fasteners for attaching brackets and three 0.5-inch (13-mm) bolt-type fasteners for attaching structural supports.

2. Attaching to existing construction: Where necessary to obtain suitable strength for load on concrete slabs or planks, bolt sections of structural channels to slab or planks, using two or more expansion shields as above, and attach hanger rod to the channel.

a. Concrete slabs: Use expansion shields and steel bolt or rod.

F. Hangers and supports shall be spaced as follows:

1. Copper pipe:
   a. NPS 1.25 (DN 32) and smaller: At least every 6 feet (1.8 m).
   b. NPS 1.5 and 2 (DN 40 and 50): At least every 8 feet (2.4 m).
   c. NPS 2.5 (DN 65) and larger: At least every 10 feet (3 m).

2. Steel pipe:
   a. NPS 1 (DN 25) and smaller: At least every 6 feet (1.8 m).
   b. NPS 1.25 and 1.5 (DN 32 and 40): At least every 9 feet (2.7 m).
   c. NPS 2 to 6 (DN 50 to 150): At least every 10 feet (3 m).

3. Trapeze hangers:
   a. Spacing shall not exceed the requirements for the smallest pipe in the rack.

G. Provide additional hangers or supports for concentrated loads such as flanges, valves, expansion compensators, fittings, and other specialties.

H. Provide hangers as required for insulated piping systems. Coordinate selection of hangers and supports with requirements and selected options for insulation continuous through hanger or butted to each side. Provide pipe covering protection shield and structural insulation insert where insulation is continuous through hangers or supports.

I. Provide pipe risers through floor slabs with riser clamps.

J. Support banks of pipes along the wall on a structural support system.

3.21 INSTALLING EQUIPMENT FOUNDATIONS AND SUPPORTS

A. Provide concrete foundations (housekeeping pads), reinforced with welded-wire fabric, for floor-mounted equipment and where indicated. Anchor concrete foundations by dowels inserted into the floor slab.

B. Unless otherwise specified, provide concrete foundations, bolts, sleeves, and appurtenances as work of the section where the supported equipment is specified and in accordance with the requirements of Division 3.

C. Equipment shall be properly aligned and leveled, and grouted where necessary. Support piping independently of equipment and so as not to cause a strain or thrust.

D. Coordinate exact size, configuration and location of equipment, foundations, and supports using approved shop drawings of equipment.

3.22 INSTALLING PIPE GUIDES
A. Install guides where indicated on the drawings and where required to properly guide piping at expansion loops and joints.

B. Install guides at distances recommended by the manufacturer, in accordance with MSS-69, and where indicated on the drawings.

C. Guides do not support piping and do not serve as hangers or supports in determining spacing of hangers and supports.

3.23 INSTALLING ANCHORS

A. Provide anchors where indicated or required by good piping practice to control pipe movement.

B. Furnish and install heavy structural angle irons, channels, and wide flange beams as required for suitable anchor supports and bracing for the piping. Arrange anchor supports to suit field conditions, to be adequate for the required duty, and to transmit the thrust loads to the building structural system or floor slabs.

1. Black steel pipes shall be welded to the supports for anchoring.

2. Galvanized and copper pipes shall be attached to the supports by pipe clamps. Clamps for copper pipes shall be copper-plated or pipe shall be wrapped with lead sleeves.

END OF SECTION
SECTION 15070

VIBRATION CONTROL SUPPORTS

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Vibration control supports for mechanical equipment.

1.14 RELATED SECTIONS

A. Hangers and supports: Section 15060.

B. Flexible pipe connections: Piping specialties.

C. Flexible duct connections: Duct accessories.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data: For each type of vibration control support included in the work.
   1. For Specification D hanger, include scaled drawing showing degrees of hanger rod swing.

C. Shop drawings: Custom-fabricated supports.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Mason Industries units are the basis for design of the project. The following listed
   manufacturers also provide units of acceptable quality. If units by any of these manufacturers
   should be proposed, verify that they meet requirements specified in the article "Product
   Options" in Section 01600.

B. Manufacturers:

   Amber/Booth Company, Inc.
   Mason Industries
   Korfund Dynamics Corporation
   Vibration Eliminator Company, Inc.
   Consolidated Kenetics Corporation
   Vibration Mountings and Controls, Inc.

2.20 VIBRATION CONTROL SUPPORTS

A. Provide engineered supports for equipment and locations shown on drawings and specified in
   Part 3 below. The units shall prevent the transmission of vibration and mechanically transmitted
   sound to the building structure.
   1. Select units in accordance with the weight distribution of the equipment, so as to produce
      reasonably uniform deflection. Deflections shall be as specified.
B. Specification A: Equal to Mason Industries ND, double-deflection neoprene type. All metal surfaces shall be covered with neoprene and have friction pads both top and bottom. Provide bolt holes for mounting. Provide steel rails where necessary to compensate for equipment overhang.

C. Specification B: Equal to Mason Industries SLFH, free-standing spring isolators, laterally stable without housing, and with 0.5-inch-(13-mm) thick neoprene pads between baseplate and support.
   1. Mountings shall have leveling bolts rigidly bolted to equipment.
   2. Springs: Spring diameters shall not be less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal of 50 percent of the rated deflection.

D. Specification D: Equal to Mason Industries Type 30N hangers, combination spring and minimum 0.3-inch (8-mm) deflection neoprene in series.
   1. Neoprene element: Molded with a rod isolation bushing that passes through the hanger box.
   2. Spring diameters and hanger box lower hole sizes: Large enough to permit the hanger rod to swing through a 30-degree arc before contacting the edges of the hole.
   3. Springs shall have a minimum additional travel to solid equal to 50 percent of rated deflection.

E. Specification E: Equal to Mason Industries Type PC30N, same as Specification D, except with adjustment to transfer load to spring while holding supported object at fixed elevation. Include spring deflection indicator.

F. Specification X: Equal to Mason Industries WB, horizontal thrust restraint, consisting of a spring element in series with a neoprene pad as described in Specification B with the same deflection specified for the mountings or hangers.
   1. Spring element: Contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 0.25 inch (6 mm) movement at start and stop.
   2. Furnish the assembly with one rod and angle brackets for attachment to both the equipment and ductwork or the equipment and the structure.
   3. Horizontal restraints: Attached at the centerline of thrust and symmetrically on either side of the unit.

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Adjust vibration control supports as recommended by manufacturer to eliminate transmission of vibration to building structure or other systems.

B. Replace springs that become permanently deformed with new springs.
C. Provide 0.25-inch structural plate sized as required between isolator and equipment.

3.21 FAN VIBRATION CONTROL

A. Suspended from structure: Provide Specification D hanger, selected for weight, with minimum 1.0 inch static deflection.

3.22 AIR-HANDLING UNIT VIBRATION CONTROL

A. Isolators for air handling units may be provided as part of the unit (internal isolation) as specified in the section, Air Handling Units with Coils, but shall meet the requirements of this section.

B. On floors above grade and on roofs: Provide number of Specification B mountings, having at least 1.75 inch static deflection, required to properly support unit and its accessories as recommended by the air-handling unit manufacturer.

1. Unit with fan section isolated from coil and filter section:
   a. Provide the Specification B mounting under fan and motor only, bolted to equipment support (housekeeping pad).
   b. Provide Specification X mounts on each side between fan and coil section to control fan section thrust upon fan start-up.

C. Suspended from structure: Provide Specification D hanger, selected for weight, with minimum 1.0 inch static deflection.

D. On slab on grade: Provide Specification A mounting with at least 0.35 inch (89 mm) static deflection, and Specification X horizontal thrust restraints if required.

3.26 PUMP VIBRATION CONTROL

A. Pumps mounted on floor slab on earth: Install without isolation base.

3.29 VIBRATION CONTROLS ON PIPING

A. Floor-mounted piping to pump: Specification A or B vibration isolator consistent with mounting of nearest isolated equipment.

B. Piping: Provide Specification E vibration control supports in first three hangers at both the suction and discharge of pumps and for the first three hangers on pipes connected to air handling units. The static deflection shall be the same as specified for the mountings under the connected equipment.

1. If piping is connected to equipment mounted on slab on grade and hangs from structure under occupied spaces, the first three hangers shall have at least 0.75 inch (19 mm) deflection for pipe sizes up to and including NPS 3 (DN 80), 1.5 inch (38 mm) deflection for pipe sizes up to and including NPS 6 (DN 150) and 2.5 inch (64 mm) deflection thereafter.

2. Other hangers and mounts shall have a minimum spring deflection of 0.75 inch.

3. Locate vibration control supports in hanger rods as close to the overhead supports as practical. On supports with double rods, use two vibration control supports.
PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Definitions and general requirements applicable to the insulation systems specified in "Related Sections."

1.14 RELATED SECTIONS

A. Pipe insulation: Section 15081.
B. Duct insulation: Section 15082.
C. Equipment insulation: Section 15083.

1.20 DEFINITIONS

A. Ceiling space: The space between the ceiling and the floor of an air-conditioned space above.
B. Roof space: The space between the ceiling and the roof, where building insulation is located at the roof level, or the space between the ceiling and the floor of a non-air conditioned space above.
C. Attic space: The space between the ceiling and the roof, where building insulation is located at the ceiling level.
D. Air-conditioned areas or spaces: Areas or spaces where the occupied room temperature is maintained between 65 and 80 degrees F (18.3 and 26.7 degrees C).
E. Concealed insulation shall include work:
   1. Above ceilings.
   2. Where furred in and in pipe chases.
F. Exposed insulation shall include work:
   1. In all rooms and areas.
   2. In mechanical equipment rooms or spaces.
   3. In storage rooms.

1.40 QUALITY ASSURANCE

A. Perform work in strict accordance with the building, fire and safety codes of the state, county or city in which the work is performed.
B. Insulation, including fittings and butt strips, jackets, facings, and accessories such as adhesives, mastics, cements, tapes and cloth, shall have a fire and smoke hazard rating and label as
tested by ASTM E84, NFPA 255, and UL 73, not exceeding Flame Spread 25, Fuel Contributed 50, Smoke Developed 50.

C. All insulation and accessories shall be free of asbestos.

1.50 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation and accessory products in manufacturers' wrapping or cartons, identified on the exterior and bearing labels showing conformance to flame and smoke rating requirements.

PART 2 - PRODUCTS

2.10 MATERIALS

A. Refer to sections listed in "Related Sections".

PART 3 - EXECUTION

Not Used.

END OF SECTION
SECTION 15081
PIPE INSULATION

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Pipe insulation for the piping systems listed in the schedule at the end of this section.

B. Work of this section includes:
   1. Insulation for new piping installed under this contract.
   2. Patching existing insulation where removed to make connections to existing piping.
   3. Patching existing insulation damaged during demolition and construction.

1.14 RELATED SECTIONS

A. Definitions and general insulation requirements: Section 15080.

B. Painting: Section 09900.

C. Pipe hangers and protection shields: Section 15060.

1.20 REFERENCES

A. ASTM C 450: Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments.

B. ASTM C 534: Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

C. ASTM C 547: Mineral Fiber Pipe Insulation.


1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Schedule of products: Each type of insulation and accessory, with manufacturer's name and material name and number. Identify locations for use, thickness of material, type of jacket, vapor barrier, and method of application.

C. Product data: Sufficient to show that the product meets the specified requirements for materials, composition, and performance.

D. Samples required only upon request.

1.34 QUALITY CONTROL SUBMITTALS

A. Manufacturer's instructions: Recommended accessory materials and products; installation instructions.
1.40 QUALITY ASSURANCE
   A. Meet requirements specified in Section 15080.
   B. Installers shall be mechanics skilled in this trade.

1.50 DELIVERY, STORAGE, AND HANDLING
   A. Meet requirements specified in Section 15080.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
   A. The listed manufacturers and particular products are intended to set a standard for materials, composition, and performance. Products of other manufacturers may be proposed as permitted by the provisions of the article "Product Options" in Section 01600.
   B. Fiberglass insulation:
      Owens-Corning Fiberglass.
      Knauf Fiber Glass GmbH.
      Johns Manville
   C. Flexible elastomeric insulation:
      Armstrong World Industries
      Rubatex
   D. Coatings, adhesives, and fabrics:
      Foster Products Corporation, an H. B. Fuller Company.
      Childers Products Company.
      Manville Building Materials Group.
      Rock Wool Manufacturing Company

2.10 FIBERGLASS PIPE INSULATION
   A. Fiberglass insulation: Glass fibers bonded with a thermosetting resin.
      1. Preformed pipe insulation, ASTM C 547 Type I, with all-service jacket.
      2. Flexible sheet insulation, ASTM C 553 Type IV, without facing.
   B. All-service jacket (ASJ): Factory-applied, fire-retardant, vapor-barrier foil/scrim/kraft jacket. All-service jacket with self-sealing lap (ASJ-SSL) is acceptable as Contractor's option.
      1. Tape: Matching jacket, pressure-sensitive.
   C. Fittings and valves: Prefabricated and field fabricated, meeting ASTM C 450 requirements for dimensions used in forming insulation to cover valves, elbows, tees, and flanges.

2.11 FLEXIBLE ELASTOMERIC PIPE INSULATION
A. Flexible elastomeric tube and sheet: Equal to Armstrong "AP Armaflex," or "Armaflex 2000", closed-cell, sponge- or expanded-rubber materials, ASTM C 534, Type I (tubular) and Type II (sheet).

B. Fitting and valve covers: Field fabricated, meeting ASTM C 450 requirements for dimensions used in forming insulation to cover valves, elbows, tees, and flanges.

2.12 ADHESIVES

A. Joints, fittings, and general application:
   2. Flexible elastomeric insulation: Armstrong 520.

B. Lagging adhesive: Polyvinyl acetate adhesive, equal to Foster "Lagfas" 81-42W.

2.13 MASTICS AND COATINGS:

A. Flexible elastomeric insulation: Armstrong "WB Armaflex" latex enamel.

B. Bituminous mastic: Fed. Spec. SS-C-153, Type I.

C. Insulating and finishing cement: Mineral fiber cement with a hydraulic-setting binder, conforming to ASTM C 449.

D. Vapor barrier coating:
   2. On flexible elastomeric insulation: Two coats of latex enamel coating.

E. Finish coating for fiberglass insulation or lagging: Washable, abrasion-resistant, coating equal to Foster "Sealfas" 30-36.

2.14 LAGGING AND REINFORCING TEXTILES

A. Canvas: Eight ounces/sq. yd. (226.8 g/0.09 sq. m), fire-retardant treated.

B. Glass cloth and tape: MIL-C-20079. Tape: Type II, Class 3, 4.5 ounce/sq. yd. (127.6 g/0.84 sq. m). Cloth: Type I, Class 1, untreated.

2.15 FASTENERS

A. Aluminum bands: 0.75 inches (19 mm) wide and 0.020 inches (0.4 mm) thick.

B. Staples: Outward clinching type, Type 304 or 316 stainless steel.

C. Pins: Serrated shaft, Type 304 or 316 stainless steel.

2.16 PROTECTIVE PIPE JACKETS

A. Aluminum: Smooth aluminum 0.016-inch-thick, lined with a bonded moisture barrier, equal to Childers "Aluminum Roll Jacketing."
   1. Aluminum straps: Same alloy as jacket.
2. Elbows: Childers "Univers-Ell Jacs".

3. Tees: Childers "Tee-Jacs."

4. Fitting covers: Manufacturer's factory-fabricated aluminum covers suitable to size of fitting and thickness of insulation.

D. Canvas: Finished with lagging coating, uniform, smooth, and ready for painting.

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Install in accordance with the Minimum Thickness Schedule at the end of this section, as modified by specifications for each location and type.

B. Fiberglass insulation: Apply insulation to a neat and smooth finish. Comply with manufacturers' recommendations and installation instructions. Butt joints tightly and apply a brush coat of joint adhesive to each lap and joint strip. Seal or fasten laps in jacketing as specified for location, pulling jacketing tight and smooth.

C. Flexible elastomeric insulation: Apply by slipping seamless sections of tubing over the end of the piping, wherever possible. Use slit tubing only as necessary. Seal joints and slit seams with joint adhesive.

1. Fittings and valves: Field fabricated from insulation same thickness as on the piping. Use manufacturer's miter tubes and boxes and templates.

D. Tape and seal all terminations of insulation.

E. Staple, tape, or seal plastic pipe fitting covers by methods recommended by manufacturer.

F. Coordination with pipe hangers and supports:

1. For the systems listed below, insulation shall be continuous through hanger. Install pipe covering protection shield with thickness of structural insulation insert equal, under load, to that of adjoining insulation. Shield and saddle support are specified in Section 15060, Hangers and Supports.

   Domestic cold water
   Chilled water

2. For the systems listed below, insulation may be continuous through hanger, installed as above, or hanger may be sized for pipe. Butt insulation at hangers and make smooth joints fitting around the hanger.

   Domestic hot water
   Recirculated hot water
   Heating water

3. For all insulated piping exterior of building heated space, insulation shall be continuous through hangers or supports.

3.21 INSTALLING INSULATION AT PENETRATIONS
A. Where the following insulated piping systems pass through sleeves or openings in partitions and floors, the insulation shall be continuous through the sleeves and openings. See Firestopping specifications, for coordinating insulation and fire protection sealing.

Chilled water
Domestic cold water
Air-conditioning condensate drain

B. Where the following piping systems pass through sleeves and openings in floors and fire rated walls, the fire-barrier sealant system shall be completed, as specified in Section 07840, Firestopping, prior to application of the insulation.

Domestic hot water
Domestic recirculated water
Heating water

3.22 INSTALLING CANVAS JACKET

A. Locations:
   1. All pipe insulation in mechanical rooms and on exposed piping as defined in Section 15080, Mechanical Insulation.
   2. Canvas jacket is not required where aluminum jacket is required.

3.23 INSTALLING ALUMINUM JACKET

A. Locations: All insulated pipe exposed in finished areas within 8 feet (2440 mm) of the finished floor.

B. Secure jacket with aluminum bands on 12-inch (305-mm) centers and at circumferential joints.

C. Place longitudinal joints to face a wall and overhead joints to face the ceiling.

3.26 INSTALLING HEATING PIPING INSULATION

A. Piping systems:

Heating water

B. Insulation: Fiberglass pipe insulation with jacket, in accordance with Minimum Thickness Schedule. Staple or seal ASJ laps at Contractor’s option.

C. Fittings and valves: Cover with prefabricated fitting covers.

D. Do not cover unions and flanges.

3.27 INSTALLING CHILLED WATER PIPING INSULATION

A. Piping systems: Insulate supply and return with fiberglass insulation in accordance with Minimum Thickness Schedule. Seal ASJ lap to form vapor barrier.

B. At all valves, flanges, and fittings, and at intervals of not more than 21 feet (6400 mm) on continuous runs of pipe, make a joint in insulation. Finish and seal ends with vapor barrier on both sides of joint.
C. Fittings, valves, and flanges: Cover with prefabricated fitting covers.

D. Insulation on strainers: Removable without damage.

3.29 INSTALLING PLUMBING PIPING INSULATION

A. Insulation: Fiberglass, thickness in accordance with Minimum Thickness Schedule.

B. Fittings, valves, and flanges: Cover with prefabricated fitting covers.

C. Seal or finish to maintain vapor barrier on the following systems:

- Aboveground domestic cold water
- Air-conditioning unit condensate drains,

D. Seal or staple ASJ as contractor's option: Aboveground recirculating and domestic hot water.

3.90 SCHEDULES

A. Minimum Thickness Schedule: Thicknesses scheduled are for aboveground, interior piping.

<table>
<thead>
<tr>
<th>MINIMUM THICKNESS SCHEDULE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PIPE SIZES (NPS)</strong></td>
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<tr>
<td>Piping System Types</td>
</tr>
<tr>
<td>Heating water</td>
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<tr>
<td>Chilled water</td>
</tr>
<tr>
<td>Domestic water</td>
</tr>
<tr>
<td>Air-conditioning condensate</td>
</tr>
</tbody>
</table>

* Contractors Option: 0.5-inch flexible elastomeric insulation.
** Contractors Option within partitions only: 0.5-inch flexible elastomeric insulation.

(1) - Connections to heating elements: Last 12 feet may be insulated with 0.5-inch flexible elastomeric.

END OF SECTION
SECTION 15082
DUCT INSULATION

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Insulation applied to ducts.

B. Work of this section includes:
   1. Insulation for new ductwork installed under this contract.
   2. Patching existing insulation where removed to make connections to existing ductwork.
   3. Patching existing insulation damaged during demolition and construction.

1.14 RELATED SECTIONS

A. Definitions of concealed, exposed, and other terms: Section 15080.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Material list: Each type of insulation and accessory, with manufacturer's name and material name and number. Identify locations for use, thickness of material, type of jacket, vapor barrier, and method of application.

C. Product data: Sufficient to show that the product meets the specified requirements for materials, composition, and performance.

D. Samples required only upon request.

1.40 QUALITY ASSURANCE

A. Meet requirements specified in Section 15080.

B. Installer qualifications: Firm with at least 5 years successful installation experience with mechanical insulation. Work shall be performed by mechanics skilled in this trade.

1.50 DELIVERY, STORAGE, AND HANDLING

A. Meet requirements specified in Section 15080.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The listed manufacturers and particular products are intended to set a standard for materials, composition, and performance. Products of other manufacturers may be proposed as permitted by the provisions of the article "Product Options" in Section 01600.

B. Insulation and accessories:
Armstrong World Industries.  
Certain-Teed Corporation.  
Foster Products Corporation, an H.B. Fuller Company.  
Knauf Fiber Glass GmbH.  
Owens-Corning Fiberglass.  
Schuller Mechanical Insulations.

2.10 MATERIALS

A. Flexible fiberglass insulation: ASTM C 553, Type I, Class B-3, K-factor of 0.27 at 75 degrees F mean temperature, of thicknesses specified in Part 3 below, nominal density at least 1 lb per cubic foot, with vapor-barrier jacket of reinforced kraft and aluminum foil.

B. Rigid fiberglass insulation: ASTM C 612, Class 2, nominal density at least 6 lbs per cubic foot, with K-factor of 0.22 at 75 degrees F mean temperature, of thicknesses specified in Part 3 below, with factory-applied jacket composed of a reinforced white kraft and aluminum-foil laminate with the white kraft facing out, equal to Certain Teed Products Corp. IB 600-ASJ.

C. Canvas: Eight ounces/sq. yd. (226.8 g/0.09 sq. m.), fire-retardant treated. Provide washable, abrasion-resistant finish coating equal to Foster "Sealfas" 30-36.

D. Adhesives for duct insulation inside buildings: Recommended by insulation manufacturer for the application, equal to Foster Products 86-20.

E. Mechanical fasteners: Perforated, 2 by 2 inches (51 by 51 mm) by 0.023-inch (0.6-mm)-thick, zinc-coated steel with one-inch (25-mm)-wide by 0.023-inch (0.6-mm)-thick diamond-notched tongue or No. 11 gauge wire nail, complete with locking plates, holding plates, fiber washers, or speed washers as required. Provide neoprene-rubber base adhesive, Type 3. Adhesive and fastener shall be equal to the products of Stic-Klip Manufacturing Co.

F. Glass cloth and tape: MIL-C-20079. Tape: Type II, Class 3, 4.5 ounces/sq. yd. (127.6 g/0.84 sq. m.) Cloth: Type I, Class 1, untreated.

G. Self-adhesive tape: Manufacturer's standard tape of material matching insulation jacket, with peelable backing and pressure-sensitive adhesive.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Apply insulation in a neat and workmanlike manner and in accordance with manufacturer's printed instructions. Butt joints tightly and apply a brush coat of adhesive to laps and joint strips. Seal laps, pulling jacketing tight and smooth. Tape joints with self-adhesive tape matching the service jacket.

B. Tape and seal terminations of insulation to prevent "dusting".

3.21 INSULATION INSIDE BUILDINGS

A. Concealed ducts: Flexible fiberglass insulation. Adhere with adhesive in sufficient quantities to prevent sagging. On ducts more than 30 inches (762 mm) wide, secure insulation on the underside with mechanical fasteners on 18 inch-(457-mm) maximum centers. Butt insulation with facing overlapping at least 2 inches (50 mm) and sealed with vapor-barrier adhesive. Adhesive must cover full 2-inch (50-mm) overlap to form an airtight seal. Seal breaks and punctures with vapor-barrier tape and same type of adhesive.
B. Exposed ducts: Rigid fiberglass insulation, fastened with mechanical fasteners. Fasteners shall be spaced 12 to 18 inches (305 to 457 mm) on center with a minimum of two rows per side of duct. Secure insulation in place with washers firmly embedded in insulation.

1. Install corner beads on external corners.

2. Seal joints. Apply canvas jacket. Cover with two coats of finish coating, ready for painting. Fastener caps shall match the jacket.

C. For curved surfaces, such as exposed elbows, score or cut insulating board in narrow strips as necessary for snug and neat fit.

D. Ductwork which need not be insulated:

1. Heating systems: Supply ducts exposed in areas they serve.

3.22 INSULATION THICKNESS

A. Outdoor air ducts: 1.5 inches (40 mm). Where necessary to conceal the standing seams and reinforcing angles on exposed ducts, 2 inches (50 mm).

B. Exhaust and pressure relief air ducts to roof ventilators or to exterior openings: 1.5 inches (40 mm), starting at connection to roof curb or opening and running back to ATC dampers but not less than 10 feet (3 m).

C. Ductwork which transmits combination cooled and heated air or untempered ventilating air shall be insulated as specified below for cooling systems.

D. Cooling systems:

1. Supply air ducts: 1.5 inches (38 mm). Where necessary to conceal the standing seams and reinforcing angles on exposed ducts, 2 inches (50 mm).

2. Return air ducts: 1.5 inches (40 mm). Where necessary to conceal standing seams and reinforcing angles on exposed ducts, 2 inches (50 mm).

   a. Exceptions:

      (1) Return ducts in attic spaces: 2 inches (50 mm).

      (2) Insulated flexible return ducts in attic spaces: Externally insulated with 1.5-inch (40-mm)-thick insulation.

3. Transfer ducts shall be insulated as specified for return ducts.

E. Heating systems:

1. Supply air ducts: 1.5 inches (40 mm). Where necessary to conceal the standing seams and reinforcing angles on exposed ducts, 2 inches (50 mm).

END OF SECTION
SECTION 15083
EQUIPMENT INSULATION

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Equipment insulation as scheduled at end of section.

B. Work of this section includes:
   1. Insulation for new equipment installed under this contract.
   2. Patching existing insulation damaged during demolition and construction.

1.14 RELATED SECTIONS

A. Definitions and general insulation requirements: Section 15080.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Material list: Each type of insulation and accessory, with manufacturer’s name and material name and number. Identify locations for use, thickness of material, type of jacket, vapor barrier, and method of application.

C. Samples required only upon request.

D. Manufacturer’s installation instructions and system recommendations.

1.40 QUALITY ASSURANCE

A. Meet requirements specified in Section 15080.

B. Installer qualifications: Firm with at least 5 years successful installation experience with mechanical insulation. Work shall be performed by mechanics skilled in this trade.

1.50 DELIVERY, STORAGE, AND HANDLING

A. Meet requirements specified in Section 15080.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The listed manufacturers and particular products are intended to set a standard for materials, composition, and performance. Products of other manufacturers may be proposed as permitted by the provisions of the article “Product Options” in Section 01600.

B. Insulation and accessories:

   Armstrong World Industries.
   Certain-Teed Corporation.
   Foster Products Corporation, an H.B. Fuller Company.
2.10 EQUIPMENT INSULATION

A. Insulation types refer to the Equipment Insulation Schedule at the end of the section. Thicknesses are scheduled.

B. Type A, insulation for heated surfaces up to 400 degrees F (295 degrees C), flat and curved 24 inches (610 mm) or more in diameter: ASTM C 612, Class 1 rigid fiberglass equipment insulation, K factor 0.26 at 75 degrees F (24 degrees C) mean temperature, density 6 lbs per cubic foot (96 kg/m³). For surfaces less than 24 inches (610 mm) diameter, and pump casings, use segmented sections.

C. Type B, insulation for cooled surfaces: Flexible elastomeric insulation, ASTM C 534, Type II, with vapor barrier facing.

D. Insulating and finishing cement: Mineral fiber cement with a hydraulic-setting binder, conforming to ASTM C 449.

E. Insulation compounds: Provide adhesives, cements, sealers, mastics, and protective finishes recommended by manufacturers of insulation for each particular application.

F. Insulation accessories: Provide staples, bands, wire, wire mesh, tape, corner angles, anchors, and stud pins recommended by manufacturer of insulation for each particular application.

G. Jacket material: Pre-sized glass cloth, not less than 7.8 ounces per sq yd (271g per sq. m).

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Insulate equipment as specified, except equipment with factory-applied insulation. Follow manufacturer’s instructions.

B. Provide removable insulation sections to cover parts of equipment which must be opened or removed periodically for maintenance, such as vessel covers, fasteners, flanges, pump casings and strainers, frames, and accessories. On large vessels, provide additional external support.

1. On hot equipment, insulate equipment surface, leaving flanges, bolts, and other accessories exposed.

2. On cold equipment, or equipment used for both heating and cooling, insulate flanges and accessories, and make insulation separately removable.

C. Maintain the integrity of vapor barriers.

3.21 INSTALLATION ON COLD SURFACES

A. Type in accordance with Equipment Insulation Schedule.

B. Cut, score, or miter insulation to fit contours of equipment. Secure with a full coating of adhesive. Provide weld pins or stick clips with washers spaced 18 inches apart. Stagger joints between layers.
C. Fill voids with small pieces of insulation applied with adhesive on all sides to maintain complete vapor barrier. Seal joints, breaks, and punctures in facing.

D. Insulation on chilled water pumps: For each pump, construct an insulated box assembly with removable cover, or access panels.

1. Size: To surround pump housing, drive shaft, and piping, including suction diffuser, and allowing clearance for draining and adjustment of pump shaft seal.

2. Construction: 18-gauge galvanized steel; formed with edge returns so that insulation is not exposed; provided with openings for drive shaft and pipes; no part resting on pump.

3. Access: Design box for disassembly or access. Provide fasteners such as clips or cam latches, so that access is possible without the use of tools.

4. Insulation: Secured to inside of box with pins and adhesive.

3.22 INSTALLATION ON HOT SURFACES

A. Type in accordance with Equipment Insulation Schedule.

B. Cut, score, or miter insulation to fit contour of equipment and secure with 0.5 by 0.015 inch (13 by 0.4 mm) galvanized steel bands on 12-inch (305-mm) centers. Use weld pins or stick clips with washers for flat surfaces, spaced 18 inches (760 mm) apart. Stagger joints where possible and fill voids with insulating cement. Apply wire mesh over entire surface of equipment and corner beads to all outside corners and edges.

3.23 INSTALLING FINISHED SURFACE

A. Apply a coat of insulating cement to smooth out surface. When cement is dry apply a coating of lagging adhesive. Embed a layer of glass cloth, overlapping all seams 2 inches (50 mm), and finish with a second coat of same adhesive.

3.99 EQUIPMENT INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>INSULATION TYPE</th>
<th>THICKNESS INCHES</th>
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</thead>
<tbody>
<tr>
<td>Heat exchangers/converters</td>
<td>A</td>
<td>1.5</td>
</tr>
<tr>
<td>Air separators</td>
<td>A</td>
<td>1.5</td>
</tr>
<tr>
<td>Heating water expansion tank</td>
<td>A</td>
<td>1.5</td>
</tr>
<tr>
<td>Fans in air-conditioning ductwork</td>
<td>B</td>
<td>1.5</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 15110

VALVES

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Valves for various piping systems.
B. Chainwheel operators.

1.14 RELATED SECTIONS

A. Piping installation and testing: Section 15050.
B. Piping systems: Sections 15140, 15155, and 15180.
C. Automatically operating valves: Section 15120.
D. Automatic water temperature control valve for domestic hot water: Section 15430.

1.20 REFERENCES

A. ASME B16.10: Face-to-Face and End-to-End Dimensions of Valves.
B. ASME B16.34: Valves - Flanged, Threaded, and Welding End.

1.30 SUBMITTALS

A. General: Comply with Section 01330.
B. Product data: For each type of valve. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.
C. Maintenance data: For inclusion in operation and maintenance manual specified in Section 01770. Include manufacturer's instructions for adjusting, servicing, disassembling, and repairing.
D. Valve charts: Furnish valve charts typed on 8.5 by 11-inch (216 by 279-mm) bond paper, showing locations of all manual and automatic control valves, and flow meters. Include:

1. Number
2. Location
3. Service
4. Function
5. Area served
E. Valve numbering system shall be approved by the Owner prior to final submittal. Place one copy of approved chart in a plastic envelope and mount on wall where directed. Provide another copy for each of the Operating and Maintenance Manuals.

1.40 QUALITY ASSURANCE

A. Ferrous valves shall conform to ASME B16.10 and B16.34 for dimension and design criteria.

B. Copper alloy valves (brass and bronze) shall have no more than 15 percent zinc in the alloy.

C. Valves in potable water service shall comply with NSF 61.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Valves shall be the products of one of the listed manufacturers, meeting specified requirements.

B. Ball valves:
   
   Apollo by Conbraco Industries

C. Butterfly valves:
   
   WKM Division of Flow Control

D. Check valves:
   
   Nibco Inc.
   Combination Pump and Valve Co.
   Mueller Steam Specialty
   Milwaukee Valve Co.
   Victaulic Company of America

E. Balancing valves:
   
   Butterfly: See above.
   Venturi ball valve readable): Taco, Gerand Engineering, or FlowDesign

F. Hose connection:
   
   Zurn, Inc.
   Josam Manufacturing Co.
   Nibco, Inc.
   Crane Co.

2.20 VALVES

A. General: Model numbers are provided below to set a standard for materials, quality of construction, and performance. Provide named products, or equal products by acceptable manufacturers listed above.

B. Ball valves:
1. Valves NPS 2.5 (DN 65) and smaller: Class 150 SWP, bronze, two-piece body, conventional port, TFE seats and seals, stainless-steel ball and stem. Extension handle for use in insulated piping. Threaded or soldered ends.

C. Butterfly valves, NPS 2.5 (DN 65) and larger: Bubble-tight shutoff in both directions at 200 psi (1379 kPa), and maintains bubble-tight rating when flange on one side is removed (dead-end service); Class 150 suitable for use with ASME B16.5 Class 125 and 150 flanges; A 516 GR.70 body, stainless-steel stem; field-replaceable EPDM sleeve and stem seals, capable of withstanding 225 degrees F (107 degrees C); equal to "Dyna Centric High Performance Valves".

1. Disk type: A 351 GR. CF 8M.

2. Operator:
   a. NPS 6 (DN 150) and smaller: Ten-position leverlock handle.

3. Provide extension handle where required in insulated piping.

4. Where used for balancing, provide memory stop.

D. Center-guided, spring-loaded silent-action type check valves:

1. Valves NPS 2 (DN 50) and smaller: Class 125, bronze body, Teflon disk, Teflon seat ring, stainless-steel stem and spring, Nibco Fig. S-480Y or T-480-Y, threaded or soldered ends.

2. Valves NPS 2.5 (DN 65) and larger: Class 125, cast-iron body, bronze trim, stainless-steel spring, Nibco Fig. W-910, wafer style.

E. Swing check valves:

1. Valves NPS 2 (DN 50) and smaller: Class 125, bronze, PTFE seat, renewable disks, Y pattern, horizontal swing, Nibco T-413-Y or S-413-Y, threaded or soldered ends.

2. Valves NPS 2.5 (DN 65) and larger: Class 125, IBBM, bolted bonnet, renewable seat and disk, horizontal swing Nibco Fig. F-918-B, flanged ends.

F. Balancing valves:

1. NPS 2 (DN 50) and smaller: Venturi ball valve (readable valve) with threaded or soldered ends, equal to Taco "Accu-Flo (ACUF)," Gerand "Balvalve-Venturi (BV)," or FlowDesign "Accusetter (AS)."
   a. Materials: Brass and bronze body, chrome-plated ball, PTFE seats and stem packing.
   b. Ratings: Entire assembly 250 psi, 250 degrees F (1725 kPa, 121 degrees C).
   c. Flow element: Low-loss, high-signal venturi section with schrader or quick-connect pressure ports, reliability one to ten and accuracy 2 percent.
   d. Stem: Blowout-proof.
   e. Memory stop: On valve section, adjustable, with extended handle.
f. Bellows type meter gauge kit with case, provide one for use on the entire project.

2. NPS 2.5 (DN 65) and larger: Butterfly valve with memory stop and venturi flow-measuring assembly.
   a. Materials: Carbon steel, ASTM.
   b. Ratings: 250 psig at 250 degrees F (1725 kPa, 121 degrees C).
   c. Flow element: Low-loss, high-signal venturi with schrader or quick-connect pressure ports, accuracy plus or minus 3 percent FS.
   d. Bellows-type meter gauge kit with case, provide one for use on the entire project.

2.21 HOSE CONNECTIONS

A. Hose connections, general: Every hose connection shall be provided with an ASSE 1052 backflow prevention device with two check valves, field testable, with outlet check valve capable of withstanding backpressure up to 125 psi (862 kPa).

   1. Where backflow prevention device is not integral with the hydrant or bibb, but added on, provide a hose connection backflow preventer equal to Woodford 37HD2, for freezing and non-freezing conditions, brass and stainless steel.

      a. Bushing: Threaded, designed to prevent the attachment of a hose if the check valve device should be removed, with O ring.

      b. Stop collar and stop screw: Stainless-steel, preventing unauthorized removal of the check valve device.

B. Hose bibbs: Compression type, with bronze body, stem, and bonnet, chrome-finished where exposed and rough brass where concealed, Class 125 WOG non-shock. Connection suitable for NPS 3/4 (DN 20) hose. Include integral vacuum breaker (if valve is disassembled, hose cannot be attached).

   1. Connecting to exposed pipe: Drain valve, equal to Nibco Figure No. 74.

2.70 CHAINWHEEL ACTUATORS

A. Manufacturers:

   Babbitt Steam Specialty co.
   Roto Hammer Industries, Inc.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

   1. Sprocket rim with chain guides: Ductile iron or cast iron, of type and size required for valve. Include zinc coating.

   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.

   3. Chain: Hot-dip, galvanized steel of size required to fit sprocket rim.
PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Install valves to be readily accessible for operation and maintenance, and with ample clearance for turning handles or operators.

B. For valves in inaccessible locations, provide access doors as specified in a related section.

C. Identify valves as specified in Section 15050, Basic Mechanical Materials and Methods.
   1. Provide tags for all valves except stop valves on individual fixtures or equipment where their function is obvious, or where the fixture or equipment is immediately adjacent. Numbers shall correspond to those shown on the Valve Chart. Attach tags to valve shaft.

D. Install chainwheel operators on valves NPS 4 (DN 100) and larger and more than 6 feet (2150 mm) above floor. Extend chains to 6 feet (1850 mm) above finished floor elevation.

3.21 INSTALLING SHUTOFF AND BALANCING VALVES

A. Install shutoff and balancing valves where indicated. Generally, install balancing valves in return lines of heating and cooling coils and elements, and shutoff valves in supply lines.

B. Shutoff valves for water piping shall be as follows:
   1. Sizes NPS 2.5 (DN 65) and smaller: Ball valves.
   2. Sizes NPS 3 (DN 80) and larger: Butterfly valves.

C. Balancing valves: Locate valve to provide 5 pipe diameters straight inlet and 2 pipe diameters straight outlet.

3.22 INSTALLING CHECK VALVES

A. Provide center-guided, spring-loaded silent-action type check valves in pumped lines, lines subject to pump pressure, and vertical lines.

B. Provide swing-type check valves in gravity lines or horizontal domestic water lines.

3.25 INSTALLING HOSE CONNECTIONS

A. Drain valves: Provide interior hose bibbs, NPS 3/4 (DN 20) or size indicated on the drawings, at every low point of a water system, and where indicated.

END OF SECTION
PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Specialties for piping systems.

1.14 RELATED SECTIONS

A. Piping: Sections 15140, 15155, and 15180.

B. Expansion tanks and air separators: Section 15122.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data: For each specialty included in the work. Include rated capacities of selected equipment and manufacturer's installation instructions where applicable. Indicate materials, finishes, dimensions, required clearances, methods of assembly of components; and piping and wiring connections.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Flexible connections, 2.5 through 12 inches:

   Amber/Booth
   Flexonics
   Mason Industries, Inc.
   Garlock Mechanical Packing Division
   Dunlop, Inc.

B. Gaskets:

   Garlock Mechanical Packing Division
   Manville

C. Unions:

   Epco Sales, Inc.
   Lochinvar Water Heater Corporation
   Victaulic Company of America
   Fernco
   Dart Union Company

D. Water strainers:

   Mueller Steam Specialty
   Spirax Sarco Inc.
E. High-capacity automatic air vents:

Hoffman Controls Corporation
Amtrol Inc.
Spirax Sarco Inc.
Taco, Inc.

F. Automatic air vents:

ITT Bell and Gossett
Hoffman Controls Corporation
Taco Inc.
Spirax Sarco Inc.

G. Manual air vents:

Taco, Inc.
ITT Bell and Gossett

2.21 FLEXIBLE CONNECTIONS, WATER

A. Flexible connections NPS 2 (DN 50) and smaller: Equal to Flexonics Series PCS, stainless steel with threaded ends in steel pipe and Series PCB, bronze with solder ends in copper pipe.

B. Flexible connections NPS 2.5 through 12 (DN 65 through 300): Equal to Mason Industries, Inc. Type MFNC. Units shall have 150 psi (1034 kPa) flanged ends with multi-layered tire cord fabric and neoprene body, and shall be complete with two 0.625-inch (16-mm) diameter control rods set in isolating rubber. Angular deflection shall be 15 degrees and minimum bursting pressure shall be 800 psi (9576 kPa). Allowable movements shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Pipe Size NPS (DN)</th>
<th>Length Face to Face-_inches (mm)</th>
<th>Axial Compression Inches (mm)</th>
<th>Axial Elongation Inches (mm)</th>
<th>Transverse Movement Inches (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 (65)</td>
<td>4.0 (102)</td>
<td>0.5 (13)</td>
<td>0.375 (10)</td>
<td>0.375 (10)</td>
</tr>
<tr>
<td>3-8 (80-200)</td>
<td>6.0 (150)</td>
<td>0.75 (19)</td>
<td>0.5 (13)</td>
<td>0.5 (13)</td>
</tr>
<tr>
<td>10-12 (250-300)</td>
<td>8.0 (205)</td>
<td>1.0 (25)</td>
<td>0.625 (16)</td>
<td>0.75 (19)</td>
</tr>
</tbody>
</table>

2.24 GASKETS AND UNIONS

A. Gaskets for flanged joints: Cross-laminated long fiber composition suitable for service, temperature, pressure and liquid with which they come in contact.

B. Unions NPS 2.5 (DN 65) and smaller: Malleable iron, equal to Dart Union Company for 200 psi. working pressure with ground bronze seats, or soldered type brass unions of equal quality.

C. Dielectric unions:
1. General: Completely isolate dissimilar metals so that electric current is below 1 percent of the galvanic current which would exist with metal-to-metal contact. Gaskets approved for the medium carried by the piping system.

2. Piping NPS 2.5 (DN 65) and smaller: Equal to unions manufactured by Eptco Sales, Inc. rated at 250 psi (1724 kPa) in accordance with ASTM F 492.

3. Piping NPS 3 (DN 80) and larger: Equal to Eptco "Model X," (companions), half flange unions, between steel body flanges and copper pipe. Include bolt insulators, and dielectric gaskets, bolts, and nuts.

4. Removable-bushing coupling: For connecting pipes of different materials and diameters, equal to "LowFlex" bolted couplings in stainless steel sheaths, with removable elastomeric bushings, manufactured by Fernco, Davison, Michigan.

5. Grooved piping: "Dielectric Waterway Fittings" equal to Victaulic Co. "Clearflow" steel threaded ends or thread to Victaulic groove with opaque, high-temperature thermoplastic copolymer liner designed for use at temperatures up to 225 degrees F (107 degrees C) and pressure up to 300 psi (2068 kPa). Complete with ring groove to lock steel casing to plastic liner.

2.25 WATER SPECIALTIES

A. Y-type strainers:

1. Equal to Spirax Sarco Model AT threaded or Model AF flanged.

2. For use in copper piping: Spirax Sarco Model BT threaded or Model BF flanged.

3. Screens in Y-type strainers: Bronze or monel having maximum 0.045-inch (12-mm) perforations.

B. High-capacity automatic air vent: For releasing air from hot or cold water lines. Float-operated type with minimum 7 cfm (3.3 L/s) capacity.

1. Materials: Cast-iron body and cover; stainless-steel valve pin and seat, and float; gasket conforming to ASTM D 1170; high-strength steel cap screws.

2. Operating limits: Maximum pressure 250 psig (1725 kPa); maximum temperature 300 degrees F (149 degrees C); hydrostatic pressure to 350 psig (2415 kPa).

C. Automatic air vent: Water vent designed for use on high pressure hot or cold water mains. Includes safety drain connection for discharging moisture entrained in the vented air. Tapped at top for 1/8-inch IPS (DN 6) built-in check valve.

1. Materials: Cast brass body.

2. Operating limits: Maximum operating pressure 150 psi (1035 kPa); hydrostatic pressure to 450 psi (3105 kPa).

D. Manual air vent: 150 psig (1035 kPa) working pressure, 212 degrees F (100 degrees C) maximum operating temperature.
E. Pressure relief valves: ASME rated, NB approved, automatic reseating type conforming to ANSI Z21.22.

1. Provide straight pressure type where installed in pipe lines and for protection of coils and cold water vessels.

2. Provide combination pressure and temperature type where installed for hot water tanks and vessels.

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Plastic piping specialties are not permitted in HVAC system ceiling plenums or shafts used to convey building HVAC air distribution.

3.21 INSTALLING FLEXIBLE CONNECTIONS

A. Make connections to base-mounted heating and chilled water pumps and to air-handling units with flexible connections, unless coils in air-handling units are otherwise isolated. Flexible connections may also be used in connections to other equipment to provide for proper alignment of piping with connection flange on equipment. Piping on house side of flexible connections shall be securely anchored.

3.23 INSTALLING GASKETS AND UNIONS

A. Gaskets shall be installed in accordance with manufacturer's recommendations.

B. Pipe connections to fixtures, control valves, equipment and appliances shall be provided with unions or flanges so that the units may be disconnected and replaced without damage to the pipe.

C. Provide dielectric unions between copper and steel piping NPS 0.5 through 2.5 (DN 15 through 65).

D. Provide dielectric half-flange unions between copper and steel in piping NPS 3 (DN 80) and larger.

3.24 INSTALLING WATER SPECIALTIES

A. Provide specialties for each piping system and for heat transfer elements, as indicated.

B. Install valves, Y-type strainers, balancing fittings, and appurtenances for unit heaters, heating and cooling coils, and heating and cooling elements.

C. In hydronic systems, provide automatic air vents where indicated and at each high point in piping. Provide 0.375-inch (DN 10) copper tubing from each automatic vent to discharge into main relief lines which discharge into nearest service tank or floor drain. Provide high-capacity type near expansion tank or air separation tank and where indicated. Install manual air vents at each terminal unit.

D. Install relief valves for water heaters and other devices where required by governing codes. Relief valve discharge shall be piped as indicated or to the nearest floor drain or to within six inches of the floor beside unit.
END OF SECTION
SECTION 15121

METERS AND GAUGES

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Meters and gauges for mechanical systems.

1.14 RELATED SECTIONS

A. Pipe installation and testing: Section 15050.

B. Valve tags and charts: Section 15110.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Shop drawings: meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

C. Product data: For each type of meter, gauge, device, and fitting specified.
   1. Scale range.
   2. Ratings.

D. Show flow measurement locations on valve charts specified in Section 15110, Valves.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Meters and gauges:
   AMETEK; U.S. Gauge
   Dresser Industries; Ashcroft
   Dresser Industries; Weksler
   Taco, Inc.
   H.O. Trerice Co.
   Weiss Instruments

B. Pressure-temperature connections:
   Peterson Equipment Company
   Utilities Materials and Controls, Inc.
   Sisco
   Texas Fairfax Company

2.11 THERMOMETERS
A. General: Industrial, adjustable angle type, accurate to within plus or minus one percent of range span, black baked enamel finish, red reading mercury tube, glass or clear acrylic plastic window, dust and moisture tight, nine-inch scale opening.

1. Graduation: To the scale shown on the drawings or of a scale so that the normal working temperature of the system is near the mid-point of the scale.

2. Case: Cast aluminum.

B. Pipe-mounted thermometers: Brass well, separable sockets.

1. Where mounted in insulated piping, thermometers shall have six-inch (150-mm) stem length and sockets with 2.5-inch (64-mm) lagging extension necks. Where mounted in uninsulated piping, they shall have 3.5-inch (89-mm) stem lengths and sockets without lagging extension.

2. Where thermometer wells only are required, provide separable socket with 2.5-inch (64-mm) lagging extension, fitted with attached chain and cap.

C. Duct-mounted thermometers: Perforated aluminum stem, length maximum 24 inches (610 mm) or of length to have end of bulb near center of duct. Provide union flange fitting where stem passes through duct side or unit casing. Provide lagging extension flange on insulated ductwork.

2.12 PRESSURE GAUGES

A. Pressure gauges shall be 4.5 inch (113 mm) dial size, accurate to within plus or minus one percent of range span, silver brazed bronze bourdon-tube system, bronze movement, aluminum dial with white background, black graduations and numerals and adjustable pointer, bottom connected.

1. Those installed adjacent to pumps or in pulsating locations shall be provided with pulsating dampeners or snubbers.

2. Case: Cast aluminum or molded phenolic plastic.

B. Graduation: To the scale shown on drawings, or so pointer is nearly straight up at system normal working pressure.

C. Gauges shall be straight pressure type, except gauges on suction side of pumps and inlet side of suction strainers shall be compound type.

D. Gauge cock (pressure gauge isolation valve):


2. Ball valve: Bronze, three-piece body, full port, with Type 316 stainless steel trim, 150 psi (1034 kPa) saturated steam, 600 psi (4137 kPa) non-shock cold water, oil, or gas, equal to Nibco 595.

2.13 COMBINATION PRESSURE-TEMPERATURE CONNECTIONS

A. Combination pressure-temperature connections: Equal to UMAC Universal Lancaster Test Plugs, Peterson "Pete's Plug," or Sisco or Fairfax P/T Plugs. Plugs shall have self-closing valve which will operate at a temperature up to 300 degrees F (149 degrees C). Body and cap
shall be brass, and shall receive either a temperature or pressure probe. Provide with a kit
including gauges and thermometers in a protective case.

2.15 FLOW MEASUREMENT DEVICES

A. On piping systems NPS 2.5 (DN 65) and larger: Equal to Gerand venturi-type flow-measuring
devices with flanged connections, rated for 250 psi and 250-degree F water.

B. Accessories: Nipples, needle valves, push-type disconnects, and metal identification tag.

C. Meter: Separate portable instrument, liquid-filled bellows differential type, complete with
carrying case, stand, hoses, and slide rule for calculating flow. Deliver one meter to Owner as
part of project closeout.

1. In piping up to 4 inches (DN 100), capable of reading 50 inches (12454 kPa) of water.

2. In piping 4 inches (DN 100) and over, capable of reading 100 inches of water (24908 Pa).

D. Provide transmitter where linked to automatic temperature control system.

PART 3 - EXECUTION

3.21 INSTALLING THERMOMETERS

A. Pipe line thermometers shall be installed as indicated on the drawings.

B. Duct thermometers for air handling units shall be located as follows, except thermometers are
not required if air system is not ducted:

1. Draw-through units: (4 per unit)

   a. OA duct: rigid bulb, minus 20 to plus 130 degrees F (minus 28.9 to plus 54.4
degrees C).

   b. RA duct: rigid bulb, plus 30 to 180 degrees F (minus 1.1 to plus 82.2 degrees C).

   c. Discharge duct: rigid bulb, plus 30 to 180 degrees F (minus 1.1 to plus 82.2 degrees
   C).

   d. Mixed air plenum: rigid bulb, plus 30 to 180 degrees F (minus 1.1 to plus 82.2
   degrees C) (on discharge side of filter).

C. Furnish and deliver to Owner at final inspection, three additional pipe line thermometers as
above specified, with 6-inch (152-mm) stem lengths, for use in the thermometer wells. Ranges
shall be minus 40 to plus 110 degrees F (minus 40 to 43.3 degrees C); 20 to 120 degrees F
(minus 6.7 to 48.9 degrees C.), and 50 to 550 degrees F (10 to 287.8 degrees C).

3.22 INSTALLING PRESSURE GAUGES

A. Each gauge connection shall have a gauge cock. Connections to pipe lines shall be 0.5 inch
(DN 15), with 0.5 inch (DN 15) by 0.25 inch (DN 8) reducer for valve, the assembly of sufficient
length to clear insulation.

B. Where gauge cocks only are called for on drawings, provide the 0.5-inch (DN 15) connections
to pipe line with reducer and the gauge cock.
C. Provide one compound and one straight pressure gauge of appropriate scale to Owner at final inspection.

3.23 INSTALLING COMBINATION PRESSURE-TEMPERATURE CONNECTIONS

A. Option: Provide combination pressure-temperature connections, complete with kits, where thermometer wells or gauge cocks only are called for on the drawings.

3.24 INSTALLING FLOW METERS

A. Install a flow meter fitting or permanently installed meter as indicated on drawings. When locating the fittings, assure that sufficient straight run of pipe is provided both upstream and downstream from fittings as recommended by the manufacturer for accurate readings. Size of fittings shall be same as pipe size.

1. Provide each fitting with an identification tag as specified for valve tags, giving station identification number, pipe size, meter scale and required flow in gpm (l/s).

2. Show flow meter locations on valve charts specified in Section 15110.

END OF SECTION
SECTION 15122
EXPANSION SYSTEM

PART 1 - GENERAL

1.11 SECTION INCLUDES
   A. Precharged diaphragm-type expansion tank for potable water system.

1.14 RELATED SECTIONS
   A. Piping: Sections 15180 and 15140.
   B. Supports: Section 15060.

1.30 SUBMITTALS
   A. General: Comply with Section 01330.
   B. Product data: Each type of expansion system or tank, including each relief and air separation device and all accessories.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
   A. General: Model names and numbers are provided in the articles below to set a standard for materials, quality of construction, options and details, and performance. Provide named products, or equal products by acceptable manufacturers listed in paragraph B.
   B. Manufacturers:
      Adamson Company, Inc.
      Amtrol, Inc.
      ITT Bell and Gossett
      Spirotherm
      Taco, Inc.

2.32 EXPANSION TANK FOR POTABLE WATER
   A. Pressurized diaphragm type tank, Taco PAX model number scheduled on the drawings, containing impermeable diaphragm which separates the air cushion from the system water. Operating temperature: 240 degrees F. maximum. Precharge to manufacturer's standard pressure.
   B. Shell: Welded steel, constructed, tested and stamped in accordance with ASME BPV for Unfired Pressure Vessels for a working pressure of 125 psi. Lined with protective coating.
   C. Diaphragm: Butyl rubber, flexible but not stretchable under working conditions, removable for inspection.
   D. FDA approval: Wetted components FDA-approved materials.
   E. Size and capacity: Shown on the drawings.
F. Supports: For horizontal or vertical support on concrete equipment foundation, as diagramed on the drawings.

2.36 AUTOMATIC AIR VENT

A. As specified in Section 15120, Piping Specialties. Float type vent, size and capacity recommended by manufacturer for tank and system.

PART 3 - EXECUTION

3.21 INSTALLING EXPANSION TANKS

A. Follow manufacturer's instructions and recommendations.

B. Install piping, air separation apparatus, and vents as diagramed on drawings.

C. Install supports as shown on drawings.

3.75 CLEANING

A. Remove and clean air separator air-removing element after 24 hours operation, and after 30 days operation.

3.81 OPERATING INSTRUCTIONS

A. As specified in Section 15050, provide operating instructions.

END OF SECTION
SECTION 15140
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Domestic cold water.

B. Domestic hot water.

C. Recirculated hot water.

1.14 RELATED SECTIONS

A. Piping materials and methods: Section 15050.

1.20 DEFINITIONS

A. Domestic water system: Potable water system for general human use, including hot and cold water supply and return.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data: Each type of pipe and fitting included in the project.

C. Certifications: Disinfection test report

1.40 QUALITY ASSURANCE

A. Potable water system components, including pipe and joining materials, shall comply with NSF 61.

PART 2 - PRODUCTS

2.11 ABOVEGROUND PIPE AND FITTINGS

A. Pipe:

1. Galvanized steel, Standard Weight, ASTM A 53, threaded, or cut grooved; roll grooved not permitted.

2. Copper tubing, ASTM B 88, Type L, hard drawn, plain end, or roll grooved; cut grooved not permitted.

B. Fittings:

1. For threaded steel pipe: Galvanized; cast iron, Class 125, ASME B16.4; or malleable iron, Class 150, ASME B16.3.
2. For plain-end copper pipe: Solder joint, cast brass, ASME B16.18, or wrought copper, ASME B16.22.

3. For grooved pipe, steel or copper:
   a. Couplings, gasket, and fittings capable of withstanding a constant temperature of 230 degrees F (110 degrees C), and 175 psi (1207 kPa) working pressure.
   b. Reducing couplings not permitted; use reducing fittings at changes in pipe size.
   c. Gaskets: EPDM.
   d. Steel: Galvanized, equal to Victaulic Style 07.
   e. Copper: Equal to Victaulic Style 606, designed to fit copper tube, coupling housing fastened with two bolts and nuts.

C. Flanges:
   1. For steel pipe NPS 3 (DN 80) and larger: Galvanized steel, threaded, ASME B16.5, Class 150.
   2. For copper pipe: Bronze, solder type, ASME B16.24, Class 150.

D. Unions:
   1. For steel pipe: Galvanized; cast iron, Class 125, ASME B16.4; or malleable iron, Class 150, ASME B16.3.
   2. For copper pipe: Cast bronze or wrought copper with solder ends, ASME B16.18 or B16.22.

E. Dielectric pipe fittings shall comply with Section 15120.

F. Elbows in piping NPS 4 (DN 100) and larger shall be long radius type.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Install domestic water piping as shown on the drawings and in accordance with the provisions of Section 15050, Basic Materials and Methods.

B. Install aboveground piping in accordance with the Schedule of Pipe Systems, Sizes, and Materials at the end of this section.

C. Provide hose connections with vacuum breakers at low points of domestic water system for drainage.

D. Provide dielectric unions between ferrous and copper piping.

3.75 CLEANING AND TESTING PIPING SYSTEMS
A. When a domestic water loop is completed, and before strainer baskets are installed, pressure test at the pressure shown in Piping Test Table in Section 15050, and thoroughly flush. Water piping connections for flushing shall be same size as piping being flushed or one size smaller. When a major section of the building is completed, repeat the same procedure, except that water pipe connections for flushing shall be limited to NPS 1.5 (DN 40). Then install strainer baskets and conduct a preliminary operation test.

3.76 FLUSHING OF DOMESTIC WATER SYSTEM

A. Flush the new domestic water piping within the building, cold, hot and return piping, before using. Unless prescribed otherwise by the county or state health department, the method of flushing shall be as follows:

1. Flush with clean water until no dirty water appears at the points of outlet.
2. Flush every connection in each new branch of piping, for a minimum of 15 minutes after running clean.

3.90 SCHEDULE OF PIPE SYSTEMS, SIZES AND MATERIALS

<table>
<thead>
<tr>
<th>System</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold water</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot water</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hot water Return</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

1. NPS 4 (DN 100) and smaller, copper Type L.
2. NPS 5 (DN 125) and larger, galvanized steel, threaded.
3. NPS 5 (DN 125) and larger, copper Type L.
4. NPS 5 (DN 125) and larger, galvanized steel, cut grooved.
5. NPS 3 (DN 80) to NPS 6 (DN 150), copper, rolled grooved.

END OF SECTION
SECTION 15155
SANITARY AND STORM PIPING

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Sanitary piping, interior.
B. Air-conditioning condensate drain.

1.14 RELATED SECTIONS

A. Piping installation and testing: Section 15050

1.30 SUBMITTALS

A. General: Comply with Section 01330.
B. Product data: Each specified material and product.

PART 2 - PRODUCTS

2.20 PIPING AND FITTINGS, TYPES

A. Install each type of pipe and fittings in locations required or permitted in Part 3, including the Pipe Installation Schedule at the end of the section.

B. Type A: Cast-iron hub and spigot pipe and fittings, ASTM A 74 service class, with lead and oakum joints.

C. Type B: Cast-iron hub and spigot pipe and fittings, ASTM A 74 service class, with lifetime neoprene gasket joints equal to Control's "Multi-Tite", Tyler's "Ty-seal", Alabama's "All-tite", or Buffalo's "Dual-Tite."

D. Type D: Copper tubing Type DWV, ASTM B 306, with wrought copper drainage fittings, ANSI B16.29; or cast-brass fittings, ANSI B16.23.

   1. For air-conditioning condensate piping smaller than NPS 1-1/4, (DN 30) copper Type L or M is permitted. Fittings: Solder joint, cast brass ANSI B16.18, or wrought copper ANSI B16.22.

E. Type E: Galvanized steel pipe, Schedule 40, ASTM A 53, with cast-iron threaded (galvanized) drainage fittings, ANSI B16.12.

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Use suitable tools and appliances for the safe and convenient handling and laying of pipe. Examine each section of pipe for defects. Do not lay any piece that is known to be defective. If any defective piece should be discovered after having been laid, remove and replace it at no change to the contract price.
B. Install piping in accordance with the Pipe Installation Schedule at the end of this section, as indicated on the drawings, and in accordance with Section 15050, Basic Mechanical Materials and Methods. Materials and work shall conform to local plumbing codes and health department regulations.

C. Thoroughly clean all pipe and fittings before installing them, and keep them clean until the acceptance of the completed work. Cap or plug ends of lines to prevent debris from entering during construction.

D. Threaded joints: In accordance with requirements of Section 15050, Basic Mechanical Materials and Methods. Where sanitary piping is above food storage, preparation, and serving areas, use litharge and glycerine pipe compound.

E. Joints in cast-iron pipe: Oakum and molten lead, thoroughly caulked and made gas- and watertight. Fill joint with lead to a depth of at least 1 inch, and make it flush with the hub of the Pipe. Option where pipe is buried in ground: Neoprene gasketed joints in lieu of leaded joints.

F. Make changes in direction of sanitary and storm water piping with approved sanitary fittings, Y branches, 1:8 or 1:16 bends.

G. In soil, waste, and vent stacks where branches occur that are smaller than stacks, provide properly sized reducing fittings.

H. Seal air-conditioning condensate drain where it passes through outside wall and provide splashblock if required.

3.27 CONNECTING TO EXISTING PIPING

A. Clean the inside of existing piping at connections to new piping, using water blasting device.

B. Blasting device: Flexible high pressure hose with self-propelling nozzle which blasts to front, sides, and rear (propulsion).

C. Operation: Blasting device is operated with water at 15,000 psi (10^7 kPa). The piping system being cleaned is not pressurized.

D. Clean from the connection point to at least 5 feet (1.5 m) outside the exterior building wall.

3.90 SCHEDULES

<table>
<thead>
<tr>
<th>MATERIAL TYPE</th>
<th>USE</th>
<th>MATERIAL TYPE</th>
<th>USE</th>
<th>MATERIAL TYPE</th>
<th>USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary, below slab on earth</td>
<td>X</td>
<td>Sanitary, interior exposed</td>
<td></td>
<td>Air condition. condensate</td>
<td>X</td>
</tr>
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<td>X</td>
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</tbody>
</table>
ALL OF THE ABOVE SUBJECT TO LOCAL PLUMBING CODE AND HEALTH DEPARTMENT REQUIREMENTS

MATERIAL TYPES (Refer to Part 2 - Products)

A - Cast iron hub & spigot, lead joint
B - Cast iron hub & spigot, rubber joint
D - Copper DWV
E - Galvanized DWV

END OF SECTION
SECTION 15180

HEATING AND COOLING PIPING

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Heating water supply and return.
B. Chilled water supply and return.

1.13 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Control valves: Section 15908.
B. Wells: Sections 15121 and 15904.

1.14 RELATED SECTIONS

A. Piping materials, installation, and testing: Section 15050.
B. Pipe cleaning and water treatment: Section 15189.

1.30 SUBMITTALS

A. General: Comply with Section 01330.
B. Product data: Each specified material and product.

PART 2 - PRODUCTS

2.10 PIPE

A. Black steel, threaded or plain end: Schedule 40, ASTM A 53.
B. Black steel, grooved: Schedule 40, ASTM A 53 Type B; NPS 3 (DN 80) and smaller, rolled grooved; NPS 4 (DN 100) and larger, cut or rolled grooved.
C. Copper tubing ASTM B 88, Type L or K hard or soft drawn, plain end or roll grooved.

2.20 FITTINGS

A. For steel piping: Cast iron, Class 125, ASME B16.1 and 16.4; malleable iron, Class 150, ASME B16.3.
   1. NPS 2 (DN 50) and smaller, threaded.
   2. NPS 2.5 (DN 65) and larger, flanged.
B. Mechanical couplings and fittings for grooved steel pipe: Equal to Victaulic Style 07 couplings with Grade E gasket. Couplings, gasket and fittings shall be able to withstand a constant temperature of 230 degrees F (110 degrees C) and 175 psi (1200 kPa) working pressure. Elbows NPS 4 (100 mm) and larger shall be long radius type.
C. Fittings for plain end copper pipe: Solder joint, cast brass, ASME B16.18; or wrought copper, ASME B16.22.

D. Fittings for grooved copper pipe:
   1. Couplings, gasket, and fittings capable of withstanding a constant temperature of 230 degrees F (110 degrees C), and 175 psi (1200 kPa) working pressure.
   2. Reducing couplings not permitted; use reducing fittings at changes in pipe size.
   3. Gaskets: EPDM.
   4. Couplings: Equal to Victaulic Style 606, designed to fit copper tube, coupling housing fastened with two bolts and nuts.

E. Welding fittings: Steel, 150 psi (1030 kPa), ANSI B16.9, products of Tube Turn, Ladish, Taylor Forge, Bonney, Vogt, or Nibco.

F. Companion flanges: 150-lb., welding neck or slip-on type, ANSI B16.5.

G. Dielectric pipe fittings shall comply with Section 15120.

H. Threaded joints:
   1. For heating and cooling water systems: Compound recommended by manufacturer for use at the temperature and pressure of the system, or "Teflon" pipe thread tape, specified in Section 15050, Basic Mechanical Materials and Methods.

I. Elbows in piping NPS 4 (DN 100) and larger shall be long radius type.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Install piping as indicated on the drawings and in accordance with provisions of Section 15050 and the piping installation schedule at the end of the Section.

B. Install automatic control valves and insertion wells furnished under Automatic Temperature Controls sections, as indicated on the drawings, and in accordance with manufacturer's instructions.

C. Provide dielectric unions between steel and copper pipe.

D. Option: Mechanically formed tee connections in copper tubing:
   1. Mechanically extracted collars shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. The collaring device shall be fully adjustable as to insure proper tolerance and complete uniformity of the joint.
   2. The branch shall be notched to conform with the inner curve of the run tube and dimpled to ensure that the penetration of the branch tube into the collar is of sufficient depth for brazing and that the branch tube does not obstruct the flow in the main line tube.
   3. Braze joints in accordance with the Copper Development Association Copper Tube Handbook using BCuP series filler metal.
4. Mechanically formed branch collars shall be listed by the National Standard Plumbing Code, BOCA, IAMPO, SBCC, HUD, U.S. Army Corps of Engineers, and Underwriters Laboratory.

5. Tee connections shall be made by personnel trained by the manufacturer's representative.

3.75 CLEANING AND TREATMENT

A. Clean piping and provide water treatment as specified in Section 15189, Water Treatment.

3.90 SCHEDULES

<table>
<thead>
<tr>
<th>HEATING AND COOLING PIPE INSTALLATION SCHEDULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor has option where more than one x appears on a line</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>Heating water</td>
</tr>
<tr>
<td>Chilled water</td>
</tr>
</tbody>
</table>

A. Schedule 40 black steel, welded; NPS 2.5 (DN 65) and larger pipe sizes with welded or flanged fittings.

B. Schedule 40 black steel, threaded; NPS 2 (DN 50) and smaller with threaded fittings, except water over 125 psi (860 kPa) and steam over 90 psi (620 kPa) shall be Schedule 80.

C. Schedule 40 black steel, rolled groove; NPS 2 and 3 (DN 50 and 80) pipe sizes with mechanical coupling and fittings.

D. Schedule 40 black steel, cut or rolled groove; NPS 4 (DN 100) and larger pipe sizes with mechanical couplings and fittings.

E. Copper tubing; NPS 2 (DN 50) and smaller pipe sizes with cast or wrought fittings.

END OF SECTION
SECTION 15189
WATER TREATMENT

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Clean heating and cooling piping systems:
   1. Heating water.
   2. Chilled water.

B. Closed heating and cooling systems: Test water and provide chemical treatment.

1.14 RELATED SECTIONS

A. Cleaning and disinfecting domestic water system: Section 15140.

B. Heating and cooling piping: Section 15180.

1.27 PERFORMANCE REQUIREMENTS

A. There shall be no nitrites, chromates, polyphosphates, or heavy metals in the chemical formulation.

B. Water treatment shall not in any way affect the life of any part of the water cooling equipment, pipe, valves, fittings, and other appurtenances.

C. Chilled water, heat pump, and chilled/heating systems shall maintain these conditions:

   pH ................................................................. 7.0 to 10.0
   Corrosion inhibitor ........................................... 50 to 100 ppm as molybdate

D. Heating water systems shall maintain these conditions:

   pH ................................................................. 7.0 to 10.0
   Corrosion inhibitor ........................................... 100 to 150 ppm as molybdate

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Shop drawings:
   1. Chemicals proposed for each treated system, with calculations showing that treatment will produce the levels required in "Performance Requirements" above.

C. Product data:
   1. Chemicals and concentrations proposed for system cleaning.

D. Certifications: Qualifications of water treatment supplier, including:
   1. Names and qualifications of staff proposed to be assigned to the project.
2. List of at least five projects meeting the requirements described in the article "Quality Assurance" below, each with name, address, and telephone number of contact person who can confirm satisfactory installation and operation of the system.

E. Water analysis.

F. Test reports required below for service visits. Submit one copy of each report directly to the Owner, and one to the Engineer.

1.40 QUALITY ASSURANCE

A. Water treatment subcontractor shall supervise the cleaning of the piping systems and submit a certificate of compliance with the specification.

1.41 QUALIFICATIONS OF WATER TREATMENT SUBCONTRACTOR

A. Contractor shall engage and the Owner shall approve an independent water treatment subcontractor, who shall provide the water treatments specified in this section.

B. Is located in the Baltimore/Washington, DC, metropolitan area.

C. Is regularly engaged in providing and servicing systems of similar type and capacity to that installed on this project.

D. Has a record of at least five projects similar to this project in type and size, which have been in place and operating satisfactorily for at least 5 years.

E. Offers 24-hour emergency service.

F. Maintains locally an adequate stock of parts and supplies to service this system and equipment.

G. Has service contracts available.

1.60 PROJECT CONDITIONS

A. Obtain water analysis from the local agency supplying water to the site, or by a test.

PART 2 - PRODUCTS

2.01 ACCEPTABLE SUPPLIERS AND MANUFACTURERS

A. Water treatment system subcontractors:

ARC Water Treatment Company, Inc.
Ecolab (Ro-Co Corp.)
Water Chemical Service, Inc.
Olin Water Services

2.10 MATERIALS

A. For cleaning heating- and cooling-piping systems: Detergent, dispersant, and other required chemicals, in accordance with approved product data.
B. For each system's chemical treatment: Chemicals in accordance with approved product data, to maintain the conditions specified in "Performance Requirements" above and similar to those in use at the SCUB serving the building.

PART 3 - EXECUTION

3.05 CLEANING PIPING SYSTEMS

A. Before adding chemicals to the system, isolate coils of heating and cooling equipment, and open bypasses.

B. Flushing portions of the system:

1. After a piping loop has been completed and prior to the installation of strainer baskets, flush that portion of the system. Connections shall be same size as piping being flushed, or one size smaller.

2. When a major section of the building has been completed, repeat the same procedure, except that pipe connections shall be limited to NPS 1.5 (DN 40).

3. Flushing shall remove sediment, scale, rust and other foreign substances.

4. After flushing, install strainers and pressure-test system and repair leaks.

C. Flushing building system: After various portions of the piping system have been tested and flushed and system is substantially completed, fill the system completely with water, venting all trapped air, and operating the pump.

1. Open a drain at the system low point while replacing the water at the same rate.

2. Continue flushing until clean water shows at the drain, but for not less than two hours.

3. After flushing, remove strainers and clean and replace them.

D. Chemical cleaning: Fill system with sufficient detergent and dispersant to remove dirt, oil, and grease.

1. Circulate for at least 48 hours.

2. Open a drain valve at the lowest point and bleed while the system continues to circulate. Assure that the automatic makeup valve is operating.

3. Continue until water runs clear and all chemicals are removed. Sample and test the water until pH is the same as pH of makeup water.

4. After chemical cleaning, remove strainers and clean and reinstall them.

5. Close bypasses and open valves to coils.

E. Submit certificate and test results.

3.22 INSTALLING CHEMICAL TREATMENT FOR CLOSED SYSTEM

A. Perform water analysis and submit recommended chemicals for treatment.
B. Install chemicals. Provide temporary pumps and chemical feeders as needed.

END OF SECTION
SECTION 15430
PLUMBING SPECIALTIES

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Drains and cleanouts.

B. Water temperature controllers.

1.14 RELATED SECTIONS

A. Piping: Sections 15140 and 15155.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data: Each specialty device or equipment, with installation instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. General: Model numbers are provided in the articles below to set a standard for materials, quality of construction, options and details, and performance. Provide named products, or equal products by the acceptable manufacturers listed.

B. Drains and cleanouts:

Ancon
Josam Company
Jay R. Smith Manufacturing Company
Wade
Zurn Industries
MIFAB

C. Water temperature controllers and mixing valve assemblies:

Powers Regulator Company
Lawler Manufacturing Company, Inc.
Leonard Valve Company
Symmons Industries, Inc.

2.23 FLOOR DRAINS

A. Equal to the Zurn catalog numbers noted on drawings. Those installed in slabs on grade and above crawl space do not require flashing clamp devices. All others shall have flashing clamp devices.

B. Floor drain P traps shall be deep seal type.

2.26 CLEANOUTS
A. Cleanouts: Equal to following Zurn Catalog numbers. Those installed in slab on grade and in slab above crawl spaces do not require membrane flashing device. All others shall have flashing devices.

B. In storm and sanitary lines:
   1. Exposed piping: Z-1445 with bronze cleanout plug.
   3. Concealed piping where more than 8 inches (205 mm) back from finished wall line: Install a sanitary 90 degrees long turn Y fitting with bronze cleanout plug extended out to finish 1 inch (25 mm) behind finished wall. Provide with Z-1460-9x9 cover plate (access panel) with vandalproof screws.

2.33 THERMOSTATIC WATER MIXING VALVE ASSEMBLY

A. Equal to Powers “Hi/Lo Cabinet Supply Fixture,” valve assembly including high- and low-capacity thermostatic mixing valves, pressure-regulating valve, automatic fail-to-cold water bypass, pressure gauges, thermometer, shutoff valves, and associated pipe and fittings, factory-assembled and -tested.

B. Thermostatic mixing valves: ASSE 1017, bronze body, with check stop and union on hot and cold water inlets, bimetal thermostat, and liquid-filled motor.
   1. High-capacity valve: Poppet and seat design.

C. Finish, valves and pipes: Rough bronze.

D. Cabinet: Wall-mounted type for field mounting to field-fabricated support stand, steel with manufacturer’s standard enamel finish.

PART 3 - EXECUTION

3.23 INSTALLING FLOOR DRAINS

A. Generally, the rims of floor drains shall be set 1 inch (25 mm) below specified floor finish level and the floor sloped to the drain so as to finish flush with the rim.

B. Floor drains shall be provided with deep seal cast-iron P traps with primer connections, including those discharging directly into storm drains.

C. Floor drains shall be covered until placed in service to prevent the entrance of any foreign matter.

3.24 INSTALLING CLEANOUTS

A. Cleanouts shall be the same size as the pipe into which they are installed, except no cleanout shall be larger than NPS 4 (DN 100).

B. Install cleanouts in horizontal piping where indicated on drawings.

3.28 INSTALLING WATER TEMPERATURE CONTROLLERS
A. Install and connect controllers where shown on the drawings, in compliance with the manufacturer's recommendations. Provide field-fabricated, welded steel frame, bolted to floor, to support water temperature controller.

END OF SECTION
PART 1 - GENERAL

1.11 WORK INCLUDED

A. In-line circulator.

1.14 RELATED SECTIONS

A. Motors: Section 15053.

B. Controls: Sections 15901 through 15910.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data: Include certified performance curves and rated capacities of selected models; shipping, installed, and operating weights; furnished specialties; and accessories for each type and size of pump specified. Indicate pumps' operating point on curves.

C. Shop drawings: Show layout and connections for pumps.

1. Wiring diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Maintenance data: For each pump specified, to include in maintenance manuals specified in Section 01770.

1.40 QUALITY ASSURANCE

A. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical Materials and Methods.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Specified units are the basis for design of the project. The following listed manufacturers also provide units of acceptable quality. If units by any of these manufacturers should be proposed, verify that they meet requirements specified in the article "Product Options" in Section 01600, and submit shop drawings as specified in article 1.30 above.

B. In-line pumps (circulators):

Taco Inc.
Deming Division of Crane Co.
ITT Bell and Gossett
Armstrong Pump Co.

2.26 IN-LINE PUMPS (DOMESTIC HOT WATER CIRCULATORS)
A. Equal to Taco Inc. Series 1600 or Series 100 of size scheduled on the drawings. Pump shall have bronze body, bronze fitted, with bronze impeller, stainless-steel shaft, cupro-nickel sleeve, 250 degrees F seals, and cartridge-type sleeve bearings. Pump flanges shall conform to ANSI B16.1.

PART 3 - EXECUTION

3.25 INSTALLING IN-LINE DOMESTIC WATER CIRCULATOR

A. In-line pumps shall be provided where indicated and shall be installed with motor in horizontal position. Provide necessary bracket to building construction to support the pump and reduce vibration in pipe work.

3.70 ADJUST AND CLEAN

A. Set pump controls for specified operation.

B. Before starting, perform preventive maintenance:
   1. Lubricate bearings.
   2. Disconnect couplings and inspect motors for proper direction of rotation.
   3. Verify that each pump rotates freely by hand. If it is bound or drags, determine the cause and correct it.
   4. Verify that pump controls are correct for the application.

3.80 STARTUP

A. Start motors.

B. Open discharge valves only.

C. Check general mechanical operations of systems and motors.

END OF SECTION
SECTION 15481
DOMESTIC WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.11 SECTION INCLUDES
   A. Shell-and-tube heat exchangers.

1.14 RELATED SECTIONS
   A. Supports: Section 15060.
   B. General information: Section 15501.
   C. Controls: Sections 15901 through 15910.

1.30 SUBMITTALS
   A. General: Comply with Section 01330.
   B. Product data: Each type of heat exchanger included in the project.
   C. Unit shown on drawings is based on the dimensions of the design basis unit specified in Part 2 below. If another acceptable manufacturer’s unit should be proposed, ascertain that it will fit in the available space. Include, with shop drawings of the unit, scale drawings similar to the contract drawings, plan and sections, showing any changes in wiring, arrangement or access made necessary to accommodate the unit furnished.
   D. Shop drawings shall show complete dimensions of complete assembled unit with accessories.

1.40 QUALITY ASSURANCE
   A. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical Materials and Methods.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
   A. Taco units are the basis for design of the project. The following listed manufacturers also provide units of acceptable quality. If units by any of these manufacturers should be proposed, verify that they meet requirements specified in the article “Product Options” in Section 01600, and submit shop drawings as specified in article 1.30 above.

   B. Shell-and-tube heat exchangers:
      Taco, Inc.
      ITT Bell and Gossett
      Patterson Kelley Co.
      Ketema-Whitlock Division

2.21 SHELL-AND-TUBE HEAT EXCHANGER
A. Equal to Taco Series L, hot water. Capacities shall be as shown on the drawings. Tube bundle shall be seamless copper-nickel, ASME constructed for minimum of 125 psi (860 kPa) working pressure, and ASME stamped.

B. Provide saddles for unit.

PART 3 - EXECUTION

3.21 INSTALLING SHELL AND TUBE HEAT EXCHANGER

A. Install saddles and steel supports for heat exchanger for unit to be supported from welded steel frame on concrete pad.

B. Supply pipe to the unit shall have a temperature regulating valve with strainer, eccentric reducer and shutoff valve. Regulating valve sensing bulb shall be located in water outlet of heat exchanger.

C. Provide one or more pressure relief valves in water inlet to each heat exchanger. Relief valves shall have discharge piped to floor drain.

3.81 OPERATING INSTRUCTION

A. As specified in Section 15050, provide operating instructions.

B. Provide at least 4 hours of additional instruction time for the equipment specified in this section, consisting of 2 2-hour periods, spread over 60 days.

END OF SECTION
PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Service for heating, ventilating, and air conditioning equipment required for the work as indicated on the drawings, including the items listed in "Related Sections".

1.14 RELATED SECTIONS

A. Operating manuals: Section 01770.
B. General project warranty: General Conditions

1.26 DESIGN REQUIREMENTS:

A. The products specified, scheduled, and shown on drawings are the basis of the design of this project.
B. For requirements affecting use of optional manufacturers, or substitutions, see Section 01600, Product Requirements, and Section 15050, Basic Mechanical Materials and Methods.

1.30 SUBMITTALS

A. General: Comply with Section 01330.
B. Shop drawings:
   1. Proposed service or test agreement of each type included in the project, showing conformance to specifications. Include detailed list of work to be performed at each visit.
C. Certifications:
   1. Each installation and service organization: A list of at least ten projects, similar to this project in type, size, and components, which have been operating satisfactorily for at least two heating and cooling seasons.
   2. Include evidence of each requirement specified in article 1.41, "Qualifications," below.

1.40 QUALITY ASSURANCE

A. Perform work in accordance with the plumbing, electrical, building, fire and safety codes of the state, county or city in which the work is performed.
B. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical Materials and Methods.
C. HVAC equipment shall meet the energy performance requirements of ASHRAE 90.1 Energy Efficient Design of New Buildings Except Low-rise Residential Buildings.

1.41 QUALIFICATIONS OF EACH SERVICE AND MAINTENANCE AGENCY
A. Regularly engaged in performing installation, startup, and service work for equipment and systems of the types included in this project.

B. Located in the Baltimore/Washington, DC, metropolitan area.

C. Staff factory-trained by the manufacturer of the equipment included in this project.

D. Provides emergency service on call 24 hours a day.

E. Maintains an adequate stock of manufacturer's genuine or approved parts to service this equipment.

F. Has service contracts available, which can meet requirements specified for the equipment and systems of this project.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 ELECTRIC WIRING FOR MOTORS, STARTERS, AND CONTROLS

A. Furnish and install and in most cases factory-wire motor starters specified under each technical section in this division. Furnish and install under Division 16 magnetic starters not specifically specified with equipment. Unless specified otherwise, automatic control devices for equipment are furnished with the equipment.

B. Unless explicitly specified otherwise, mount and completely wire under Division 16 all starters and automatic control devices, except those which are factory-mounted on equipment.

C. Unless specified otherwise, motor disconnects, manual starters, pushbutton stations, and pilot lights are specified in Division 16, Electrical. Equipment specified in Division 15 shall be suitable for operation in conjunction therewith.

D. Unless specified otherwise in a particular section, electric motors shall comply with the requirements of Section 15053.

3.59 IDENTIFICATION

A. Identify equipment as required in Section 15050, Basic Mechanical Materials and Methods.

B. Thermometers, gauges, and control devices shall be identified.

3.61 TESTING MECHANICAL EQUIPMENT

A. Check and adjust all heating and cooling equipment installed.

B. Mechanical equipment shall be proven to function properly by actual operation prior to final acceptance.

3.71 EQUIPMENT LUBRICATION

A. Bearings of equipment shall be provided with adequate facilities for lubrication. Oiling devices shall be accessible. Lubricate bearings upon completion of work prior to startup of the equipment. Lubricants shall be as specified by equipment manufacturers.
SECTION 15705
HVAC PUMPS

PART 1 - GENERAL

1.11 SECTION INCLUDES
A. Base-mounted pumps.
B. In-line circulators.

1.14 RELATED SECTIONS
A. Motor: Section 15053.
B. Power factor correction: Section 15053.
C. Vibration-control supports: Section 15070.

1.30 SUBMITTALS
A. General: Comply with Section 01330.
B. Product data: Base-mounted pumps, in-line circulators.
   1. Include description of all options and accessories.
C. Include data verifying compliance with ASHRAE 90.1, or provide certified performance ratings
   by a qualified independent testing agency.
D. Unit shown on drawings is based on the dimensions of the design basis unit specified in Part 2
   below. If another acceptable manufacturer's unit should be proposed, ascertain that it will fit in
   the available space. Include, with shop drawings of the unit, scale drawings similar to the
   contract drawings, including plans, and sections, showing any changes in the wiring,
   arrangement, or access necessary to accommodate the unit furnished.
E. Shop drawings shall show complete dimensions of complete assembled unit with accessories.
F. Include wiring diagram showing factory and field wiring for each unit.

1.40 QUALITY ASSURANCE
A. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical
   Materials and Methods.
B. HVAC equipment shall meet the energy performance requirements of ASHRAE 90.1.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Scheduled units are the basis for design of the project. The following listed manufacturers also
   provide units of acceptable quality. If units by any of these manufacturers should be proposed,
   verify that they meet requirements specified in article "Product Options" in Section 01600, and
   submit shop drawings as specified in the article "Submittals."
B. Base-mounted end-suction pumps

Taco Inc.
ITT Bell and Gossett
Weinman Pump Co.
Armstrong Pump Co.

C. In-line pumps

Amtrol
Taco Inc.
Deming Division of Crane Co.
ITT Bell and Gossett
Armstrong Pump Co.

2.30 BASE-MOUNTED PUMPS, GENERAL

A. Pump shall have capacities and current characteristics as shown on the drawings.

B. Pumps shall be factory-assembled and -tested. Casings shall allow removal and replacement of impellers without disconnecting piping.

C. Motors: Comply with requirements of Section 15053.

1. 0.5 hp (0.37 kW) and larger: Suitable for 3-phase current of voltage scheduled on drawings.

2. Motors smaller than 0.5 hp (0.37 kW) shall have built-in overload protection, shall be permanent split-capacitor type, and shall be suitable for 120-V, single-phase current.

3. Motors 10 hp (7.5 kW) and larger shall be power factor corrected as specified in Section 15085.

D. Pump seals shall be internally flushed (self-flushing) type:

1. Mechanical seals shall consist of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket rated for 250 degrees F (120 degrees C).

E. Pump couplings: Flexible, capable of absorbing torsional vibration and shaft misalignment, complete with metal coupling guard. For pumps operating with variable-frequency drives, provide couplings suitable for variable-speed duty.

F. Mounting frame: Factory-welded frame and cross members, fabricated of steel channels and angles conforming to ASTM B 36. Fabricate for mounting pump casing, coupler guard, and motor. Grind welds smooth prior to application of factory finish. Mounting holes for field-installed motors shall be field-drilled.

G. Motor: Secure to mounting frame with adjustable alignment.

2.31 BASE-MOUNTED END-SUCTION PUMPS

A. Taco FE Series, or Bell and Gossett 1510. Comply with general requirements for base-mounted pumps above.
B. General description: Pumps shall be base-mounted, centrifugal, close-coupled, end-suction, single-stage, bronze-fitted, vertical (radially) split-case design, and rated for 175 psig (1200 kPa) working pressure and 250 degrees F (120 degrees C) continuous water temperature.

C. Casing construction: Cast iron, with flanged piping connections, and threaded gage tappings at inlet and outlet flange connections.

D. Impeller construction: Statically and dynamically balanced, closed, single-suction, fabricated from cast bronze conforming to ASTM B 584, keyed to shaft and secured by a locking capscrew.

E. Pump shaft and sleeve: Steel shaft, with bronze sleeve.

F. Bearings: Ball.

G. Provide suction diffuser with adjustable support foot, inlet connection to suit pipe size, outlet to suit pump suction size, angle-type body with inlet vanes, and stainless steel combination diffuser/strainer with 3/16-inch (4.8-mm) diameter openings. The flow direction shall be from inside to outside. Include disposable fine mesh bronze strainer.

2.33 IN-LINE CIRCULATOR PUMPS

A. Taco Inc. Series 1600 or Series 100, Bell and Gossett Series 60, or Armstrong Series 1000. Each pump shall have capacity and current characteristics shown on the drawings.

B. General: Horizontal in-line, centrifugal, close-coupled, single-stage, radially split-case design, with mechanical seals and resiliently mounted motor.

1. Seals: Rated for 250 degrees F (120 degrees C) operating temperature.

C. Casing construction: Cast iron, bronze fitted, with flanged piping connections conforming to ASME B16.1; operating pressure 175 psig (1200 kPa) maximum.

D. Impeller construction: Statically and dynamically balanced, closed, overhung, single-suction, fabricated from cast bronze, and keyed to shaft.

E. Pump shaft and sleeve: Steel shaft and cupro-nickel sleeve. Provide finger (slinger) on shaft between motor and seals to prevent liquid that leaks past pump seals from entering motor bearings.

F. Bearings: Replaceable bearing cartridge, oil-lubricated, steel and cupro-nickel journal and thrust type.

G. Couplings: Flexible, capable of absorbing torsional vibration and shaft misalignment.

2.34 VERTICAL IN-LINE PUMPS

A. Taco Series KV, vertical, in-line, centrifugal, single-stage. Include vertical-mounting, bronze-fitted design and mechanical seals rated for 125-psig (860-kPa) minimum working pressure and a continuous water temperature of 225 deg F (107 deg C).

B. Casing: Cast iron, drain plug at low point of volute, and threaded gage tappings at inlet and outlet connections.

C. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, single suction, and keyed to shaft.
D. Wear rings: Replaceable, bronze casing ring.

E. Shaft and sleeve: Ground and polished stainless-steel shaft with bronze sleeve.

F. Seals: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat rated to 250 degrees F, and flexible bellows and gasket.

G. Motor: Directly mounted to pump casing and with lifting and supporting lugs in top of motor enclosure.

2.35 DRIVE PROTECTION

A. Pumps shall be provided with guard over belt drive or flexible couplings as required by OSHA and MOSHA.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Base-mounted pumps:
   1. On slab on grade, anchor to concrete equipment foundation.
   2. Make final pump alignment after grouting and installation.

B. Provide in-line pumps where indicated, with motor in correct position. Provide necessary bracket to building structure to support the pump independently from the piping.

C. Heating and cooling pumps shall have balancing valves with a memory stop in discharge piping for setting proper flow and head. Check valve in discharge lines shall be non-slam spring-loaded type. Provide valves for isolating pump on both suction and discharge sides of each pump.

D. Provide valved gauge connections at suction diffuser of vertical split-case pump, and outlet for measuring pressure drop across strainer. After 30 days of operating the pump, remove the bronze disposable strainer from suction diffuser.

3.81 OPERATING INSTRUCTIONS

A. As specified in Section 15050, provide operating instructions.

B. Provide at least one hour of additional instruction time for the equipment specified in this section.

END OF SECTION
SECTION 15721

AIR-HANDLING UNITS WITH COILS

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Installing prepurchased air-handling units with water coils for heating and cooling.

1.14 RELATED SECTIONS.

A. Responsibilities for prepurchased equipment: Section 01100.

B. Motors: Section 15053.

C. Power factor correction for motors: Section 15053.

D. Filters: Section 15861.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLER

A. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet manufacturer's recommendations and requirements indicated on the drawings.

3.20 INSTALLATION

A. Assemble and set air-handling units in place as shown on drawings. Provide necessary additional structural members for support from above or below.

B. Provide field-fabricated, double-wall, insulated bypass plenum between the bypass damper discharge and the downstream bypass inlet. Plenum shall be full width of the air handling unit and at least as high as bypass damper height.

C. Provide duct and piping connections to units in a manner which allows access to removable panels. Piping assemblies shall be arranged to provide full clearance in front of access doors.

D. Provide connection flanges for ductwork to unit casing in a manner which maintains the structural integrity of the unit and does not interfere with removability of adjacent casing panels.

E. Install dielectric pipe fittings at water coil connections where dissimilar metals are joined.

F. Install throwaway filter provided with unit prior to energizing the unit supply fan.

G. Prior to air balancing, remove throwaway filter and install new medium-efficiency disposable filter as specified in Section 15861.

H. Coordinate with air balancing and provide the proper drive and belts or fan speed to obtain the airflow and static pressure indicated on the drawings.
3.81 OPERATING INSTRUCTIONS

A. As specified in Section 15050, provide operating instructions.

B. Provide at least 2 hours of additional instruction time for the equipment specified in this section.

END OF SECTION
SECTION 15763
FAN-COIL UNITS

PART 1 - GENERAL

1.11 SECTION INCLUDES
A. Installing prepurchased fan-coil units with water coils for heating and cooling.

1.14 RELATED SECTIONS
A. Responsibilities for prepurchased equipment: Section 01100.
B. Motors: Section 15053.
C. Filters: Section 15861.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.20 INSTALLATION
A. Place unit in position and make sure that it is level. Leveling is critical to assure proper drainage and operation.
B. Install unit in accordance with the drawings and the manufacturer's instructions.
C. Provide dielectric pipe fittings at water-coil connections where dissimilar metals are joined.
D. Provide wiring for thermostat and speed switch.
E. Install throw-away filter provided with unit prior to energizing the unit supply fan.
F. Prior to air balancing, remove throw-away filter and install new filter as specified in Section 15861.
G. Coordinate with air balancing to provide the proper drive and belts or adjust fan speed to obtain the air flow and static pressure indicated on the drawings.
H. Install shrouds furnished with fan-coil units to cover area between top of unit and ceiling above. Provide fasteners in accordance with manufacturer's recommendations. Field trim shrouds in basement to accommodate horizontal piping entering and leaving space between unit and ceiling, and provide escutcheon plates.

3.81 OPERATING INSTRUCTIONS
A. As specified in Section 15050, provide operating instructions.
B. Provide at least 2 hours of additional instruction time for the equipment specified in this section, consisting of periods of 2 consecutive hours, during a period of not less than 60 days.
SECTION 15768
UNIT HEATERS

PART 1 - GENERAL

1.11 SECTION INCLUDES
A. Cabinet unit heaters.

1.14 RELATED SECTIONS
A. Supports: Section 15060.
B. Motors: Section 15053
C. Filters: Section 15861.
D. Controls: Sections 15901 through 15910.

1.30 SUBMITTALS
A. General: Comply with Section 01330.
B. Product data: Each type of heater included in the work.
C. Samples: Color chips for finish selection, manufacturer's complete line of colors and textures.
D. Unit shown on drawings is based on the dimensions of the design basis unit specified in Part 2 below. If another acceptable manufacturer's unit should be proposed, ascertain that it will fit in the available space. Include, if necessary, scale drawings similar to the contract drawings, including plans, elevations, sections, and diagrams, showing any changes in wiring, arrangement, or access necessary to accommodate the proposed unit. Show complete dimensions of complete assembled unit with accessories.
E. Submit product data which verifies compliance with ASHRAE 90.1, or provide certified performance ratings by a qualified independent testing agency.

1.40 QUALITY ASSURANCE
A. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical Materials and Methods.
B. HVAC equipment shall meet the energy performance requirements of ASHRAE 90.1.
C. Components and installation shall comply with NFPA 70 (NEC).
D. Components and assembled units shall be listed and labeled.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Scheduled units are the basis for design of the project. The following listed manufacturers also provide units of acceptable quality. If units by any of these manufacturers should be proposed,
verify that they meet requirements specified in the article "Product Options" in Section 01600, and submit shop drawings as specified in the article "Submittals" above.

B. Cabinet unit heaters:

Airtherm Manufacturing Company
McQuay-Snyder General Corporation
American Air Filter
The Trane Company
Vulcan Radiator Corporation
Sterling

C. Propeller unit heaters:

Airtherm Manufacturing Co.
McQuay-Snyder General Corporation.
American Air Filter.
Dunham-Bush, Inc.
The Trane Company.
Vulcan Radiator Corporation.
Sterling

2.31 CABINET UNIT HEATER

A. Arrangement, capacities, and current characteristics are indicated on the drawings.

B. Unit shall be complete with fan, motor, heating element, and cabinet with inlet and outlet grilles.

C. Cabinet: Steel, at least 16-gauge, phosphatized and finished with baked enamel in a color to be selected.

1. Cabinet bottom on horizontal units shall be removable for access to motor, fans, heating element and appurtenances.

D. Fan: Forward curved, double-inlet type, designed for quiet operation, directly driven.

E. Heating element: Constructed of copper tubes with non-ferrous fins.

F. Motor: Resiliently mounted, three-speed, tap-wound with built-in overload protection, suitable for operation on 115-V, single phase, 60-cycle current, permanent split-capacitor type. Generally, capacities are to be selected at medium or low speed. Motors shall comply with requirements of Section 15085.

G. Unit controls: Unit-mounted fan-speed switch and wall-mounting thermostat.

H. Each unit shall have a filter rack to accommodate at least a 1/2-inch-thick filter, arranged to provide at least one sq. ft. of filter medium surface for each 300 cfm air delivery. Provide throwaway filter with each unit.

2.32 PROPELLER UNIT HEATER

A. Type, capacity, and current characteristics are indicated on the drawings.

B. Casing: Steel, phosphatized and finished with baked enamel.
1. Horizontal units: Furnished with double-deflection louver to allow for horizontal and vertical deflection of air pattern.

C. Heating element: Copper or copper alloy tube, welded or brazed. Extended surfaces shall be aluminum plate fins with tube expanded into collar.

D. Fan: Directly connected to single-speed electric motor and provided with wire guard. Motors shall comply with requirements of Section 15053.

PART 3 - EXECUTION

3.05 PREPARATION

A. Coordinate with work of other trades to assure that substrates and supports meet requirements for installation tolerances and other conditions.

3.20 INSTALLATION, GENERAL

A. Install unit as shown on drawings, according to manufacturer's instructions, and in accordance with NFPA 90A.

B. Set each unit plumb and level and assure that coils drain properly.

C. Install securely fastened in place.

3.21 INSTALLING CABINET UNIT HEATERS

A. Install piping and electrical connections concealed.

B. Filters:
   1. Install throwaway filter provided with unit before energizing the unit fan.
   2. Before air balancing, remove throwaway filter and install disposable, medium-efficiency filter specified in Section 15861, Filters.

C. Assure that all components are accessible when front panel is open.

3.22 INSTALLING PROPELLER UNIT HEATERS

A. Suspend from structure above with hanger rods not less than 0.5 inch in diameter.

B. Install in a manner and, if necessary, with vibration control devices so that vibration is not transmitted to the structure.

3.70 ADJUSTING

A. For cabinet unit heaters, coordinate with air balancing subcontractor to adjust fan speed to obtain the airflow and static pressure shown on the drawings. If necessary, provide belts, sheaves, or other parts required to complete balancing.

END OF SECTION
SECTION 15769
UNIT VENTILATORS

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Installing prepurchased unit ventilators with face and bypass damper control.

1.14 RELATED SECTIONS

A. Responsibilities for prepurchased equipment: Section 01100.

B. Motors: Section 15053.

C. Vibration control: Section 15070.

D. Filters: Section 15861.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Install dielectric pipe fittings at water coil connections where dissimilar metals are joined.

B. Test each drain pan and assure that installed slope is as specified and pan drains completely.

C. Install throwaway filter provided with unit prior to energizing the unit supply fan.

D. Prior to air balancing, remove throwaway filter and install medium-efficiency disposable filter for regular service.

E. Coordinate with air balancing to obtain the airflow and static pressure indicated on the drawings by providing the proper drive and belts or by adjusting fan speed.

3.21 INSTALLING FLOOR-MOUNTED UNIT VENTILATORS

A. Install units and cabinets as indicated on the drawings and as recommended by the manufacturer's instructions.

3.81 OPERATING INSTRUCTIONS

A. As specified in Section 15050, provide operating instructions.

B. Provide at least 2 hours of additional instruction time for the equipment specified in this section.

END OF SECTION
SECTION 15810

DUCTS

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. HVAC supply, return and exhaust metal ductwork and plenums in pressure classes from minus 2 to plus 10 inches wg (minus 500 to plus 2490 Pa).

B. Sealants.

C. Duct leakage testing.

1.14 RELATED WORK SPECIFIED ELSEWHERE

A. Firestopping: Section 07840.

B. Insulation: Section 15082.

C. Balancing: Section 15950.

1.20 REFERENCES

A. SMACNA HVAC DCS: SMACNA HVAC Duct Construction Standards, Metal and Flexible.


D. ASTM D 1330: Rubber Sheet Gaskets.

E. UL 181: Factory-Made Air Ducts and Air Connectors.

1.21 DEFINITIONS

A. Seam: Joining of two longitudinal (parallel to the direction of airflow) edges of duct surface material. All other duct surface connections are joints.

B. Joints: Transverse joints (perpendicular to the direction of airflow); branch and subbranch intersections; duct collar tap-ins; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.27 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Do not change the layout or configuration of the duct system except as specifically approved in writing. Accompany requests for modifications with calculations showing that the proposed design will provide the original design results without increasing the system total pressure.

1.30 SUBMITTALS

A. General: Comply with Section 01330.
B. Shop drawings:

1. Schedule of duct systems with applicable pressure classes and leakage classes.

2. Fabrication, assembly, and installation for each duct system: Indicate duct dimensions, sheet metal thickness, reinforcement spacing, and seam and joint construction; and components and attachments to other work.

3. Calculations when required as specified in the article "System Performance Requirements" above.

4. Schedule of sealing methods for each type of seam and joint.

C. Product data:

1. Hangers and supports.

2. Joint and sealing materials.

3. Manufacturer's installation instructions.

D. Test reports: Air Duct Leakage Test Summary: Submit data on forms as indicated in the SMACNA HVAC Duct Leakage Test Manual. (See sample form at end of section.)

1.40 QUALITY ASSURANCE

A. Specified and scheduled duct construction exceeds SMACNA requirements. Comply with specifications and schedules, and for materials or methods not specified or scheduled, comply with SMACNA HVAC DCS and RIDCS.

B. Comply with NFPA 90A and 90B.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufactured joint connectors:

Ductmate Industries
Ward Duct Connector Industries

B. Products of other manufacturers may be proposed as permitted by the provisions of the article "Product Options" in Section 01600.

2.10 MATERIALS


B. Reinforcement shapes and plates: Galvanized steel where installed on galvanized sheet steel ducts; carbon steel on carbon steel ducts and compatible materials on copper, aluminum, and stainless steel ducts.

C. Tie rods: Galvanized steel, minimum diameter 0.25 inch (6 mm) for ducts up to 36 inches (900 mm); 0.375 inch over 36 inches (900 mm).
D. Vapor barrier: Polyethylene sheet, 6 mils (0.15 mm) thick, conforming to Federal Specification UU-P-147 for permeability.

2.11 JOINT AND SEALING MATERIALS

A. Flexible joint material for connections to vibrating equipment: Specified in Section 15820, Duct Accessories.

B. Duct joint and seam sealants: UL classified, fire-resistive, conforming to NFPA 90A and 90B, high pressure type (up to 10 inches (2490 Pa) SMACNA pressure class) equal to the following products:

   1. Indoor application: Hardcast "Iron Grip" (IG-601) brush-on water-based vinyl acrylic sealing mastic.

   2. Silicone sealant (clear): Dow Corning 795, ASTM 920, Type S, Grade NS, Class 25, single component, indoor/outdoor application, UV resistive.

2.23 HANGERS AND SUPPORTS

A. Hangers: Galvanized sheet steel, or round, galvanized steel, threaded rod.

   1. Straps and rod sizes: Conform to SMACNA HVAC DCS for sheet steel width and gauge and steel rod diameters.

B. Duct attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

2.80 FABRICATION

A. Verify field measurements and resolve conflicts, before beginning to fabricate ductwork, as specified in Part 3 below.

2.81 DUCT CONSTRUCTION:

A. Construct ductwork using the Duct Construction Schedule on the drawings. Schedule includes duct system pressure class requirements, minimum sheet metal gauges, leakage allowances, and maximum reinforcement spacing. These requirements exceed the requirements of SMACNA HVAC DCS.

B. Construct ductwork of galvanized steel, except where another material is noted on drawings or specified.

C. Construct gravity duct systems (nonfan-powered), such as pressure relief and transfer, in accordance with SMACNA HVAC DCS minimum one inch pressure class unless otherwise scheduled.

D. Crossbreak or bead ducts of dimensions of 12 inches (305 mm) and over in pressure classes under 2 inches (500 Pa).

E. Plenums, casings, and access doors: Construct in accordance with SMACNA HVAC DCS.

   1. Casings and plenums for negative pressures greater than 3 inches wg (747 Pa):
      Construct in accordance with SMACNA RIDCS.
2. Where casings and plenums are on the suction side of fans, and negative pressure which exceeds their construction class may occur, provide safety relief panels or dampers as indicated on drawings.

F. Joint connections shall be constructed in accordance with SMACNA HVAC DCS, or with a manufactured duct connection system equal to Ductmate Industries "Ductmate," selected to assure compliance with leakage factors indicated on the drawings.

G. Engineered duct systems using metal gauges or reinforcing less than required in the schedules on the drawings are not acceptable.

H. Where not otherwise specified, scheduled, or detailed, construct ductwork in accordance with SMACNA HVAC DCS.

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Before fabricating ductwork, make field measurements and coordinate layout of ductwork shown on the drawings with building components and work of other trades. Resolve conflicts and obtain written approval for deviations before fabrication.

B. Provide duct systems complete with built-in accessories as specified herein, in other sections of the specifications, as indicated on the drawings, and, where not otherwise indicated, in accordance with SMACNA HVAC DCS.

3.21 INSTALLING METAL DUCTWORK

A. Provide ductwork shown on drawings and specified herein.

B. Ductwork shall not penetrate rated partitions where fire or smoke dampers are indicated on the drawings. Connect ductwork only after the damper installation is complete and accepted, as specified in Section 15820, Duct Accessories.

C. Connecting duct to louver: Provide angles or damper collars as required. Slope duct down toward louver. Blank off any part of louver not required to be open, with double pan panels constructed of the same material as the connecting duct, 1.5 inches (38 mm) thick and insulated with 1.5 inches (38 mm) of fiberglass insulation. Seal connection.

D. Install metal ductwork neat in appearance. Interior surfaces shall be smooth and free of obstructions. Duct lines shall be true and smooth. Where ducts pass through openings in partitions, ceilings and floors, fit them with trim angles to close joint between duct and construction.

E. Support ductwork on metal straps or rods in accordance with SMACNA HVAC DCS and as specified. Comply with manufacturers' load ratings and application data for each type of support and fastener.

1. Connections to substrate:

   a. Concrete: Inserts or fasteners specified in Section, Hangers, Supports, and Anchors. Install inserts before placing concrete.

   b. Precast concrete planks: Toggle bolts.

   c. Structural steel: Beam clamps.
2. Ducts 54 inches (1372 mm) wide and under. Strap hangers shall extend down sides of ducts and attach to underside with at least two sheet metal screws per strap. Straps shall be made of the same metal as the ducts they are attached to.

3. Support horizontal ducts within 2 feet (610 mm) of each elbow and within 4 feet (1220 mm) of each intersection, in addition to spacing required by SMACNA.

4. Support vertical ducts at a maximum interval of 16 feet (4.9 m) and at each floor.

F. Except in systems with minimum velocity standards, contractor has the option to eliminate reducing transitions and extend ductwork full size, providing space is available and conflict with work of other trades does not occur.

G. Make bends and turns in ductwork using offsets and curved or square elbows as indicated on the drawings. Provide full radius elbows (centerline radius equals 1.5 times duct width). Provide turning vanes in square elbows, as specified in Section 15820, Duct Accessories. Make 90-degree branch duct connections using 45-degree entry fittings where indicated.

H. Provide for and install in ductwork all automatic control systems dampers, thermometers, coils, sound attenuators, duct accessories and similar equipment furnished under this or other sections of the specifications. Where ATC dampers with frames and other accessories are mounted in ductwork, the ducts shall connect to the accessory frame in manner to provide 100 percent free area for air passage. Seal duct connections to frames with gaskets or duct sealant. Secure connections with pop rivets or sheet metal screws spaced no more than 3 inches (75 mm) on centers around both sides of entire frame. Provide angle iron or channel frames as required for mounting ATC dampers and manual dampers over weatherproof louvers for air intakes and exhaust.

I. Generally, it is intended that all horizontal ductwork be a minimum of 10 inches (255 mm) above suspended ceiling (where applicable) to allow for removal of ceiling panels and ceiling-mounted light fixtures and devices.

J. Large ductwork in mechanical equipment rooms, such as outside air, return air, and exhaust air duct connections to fans, air handling units, plenums, and appurtenances, shall be sufficiently braced with angle irons to prevent vibration and duct damage, and to reduce noise level.

K. Where noted on the drawings provide sheet metal drain troughs under piping.

3.22 SEALING DUCTWORK

A. Ducts shall be sealed so that they meet leakage factors scheduled on the drawings.

B. Prior to sealing, ductwork shall be clean and dry, free of oil or grease.

C. Apply sealant in accordance with the manufacturer’s recommendations.

D. Product application:
   1. Galvanized steel: Brush-on or pressure sensitive sealant, as applicable.

E. Allow time for sealant to dry or cure, in accordance with manufacturer’s recommendations, before leak testing.

3.59 IDENTIFICATION
A. Mark ductwork in accordance with requirements for identification specified in Section 15050, Basic Mechanical Materials and Methods.

3.61 AIR DUCT LEAKAGE TESTS

A. Leakage test procedures shall be in accordance with SMACNA Leakage Test Manual.

B. After installation and prior to insulating, test the ductwork for air leakage. Ducts to be tested, test pressures, and leakage factors (maximum volume of leakage per 100 sq ft (9.3 sq m) of duct surface area) shall be as scheduled on the drawings.

C. Conduct tests before any equipment is connected that would be subject to damage from the test pressure. Provide temporary blank-offs or caps.

D. Notify parties whose presence is necessary for the test; and in all cases, the Engineer and testing and balancing subcontractor at least two normal work days prior to the actual test.

E. While system is under test pressure, survey joints for audible leaks. Mark leakage points, shut down blower, and make repairs. Retest after duct sealant has dried or cured.

F. If test duct sections exceed the allotted leakage levels, locate sources of leakage, make repairs and repeat test procedures until acceptable leakage levels are demonstrated.

G. During the installation, continuously examine ductwork to ascertain that it is sealed properly.

END OF SECTION
Leakage test form follows Section
# AIR DUCT LEAKAGE TEST SUMMARY

**AIR SYSTEM** ____________________________
**FAN CFM (Q)** ____________________________
**LEAKAGE CLASS (Gₐ)** ____________
**SPECIFIED TEST PRESSURE (Pᵣ)** ____________
**DUCT CONSTRUCTION PRESSURE CLASS (Pₑ)** ____________

## DESIGN DATA

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<th>ALLOWABLE LEAKAGE</th>
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<th>PRESSURE *W.G.</th>
<th>ACROSS ORIFICE</th>
<th>DATE</th>
<th>PERFORMED BY</th>
<th>WITNESSED BY</th>
<th>ACTUAL CFM</th>
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UMBC Patapsco Hall  
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Ducts  
15810 - 7  
SMACNA HVAC Air Duct Leakage Test Manual–1st Ed.
SECTION 15820

DUCT ACCESSORIES

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Products and devices installed in ducts.
B. Flexible joint fabric.
C. Bird screen.
D. Instrument test holes.
E. Air turning vanes.
F. Duct access doors.
G. Sound attenuators.
H. Dampers.
I. Duct clamps.

1.14 RELATED SECTIONS

A. Duct-mounted detectors: Section 13851.
B. Damper actuators: Automatic temperature control sections.

1.20 REFERENCES

C. NFPA 90A: Installation of Air Conditioning and Ventilating System.
D. NFPA 90B: Installation of Warm Air Heating and Air-Conditioning Systems.
F. SMACNA HVAC DCS: HVAC Duct Construction Standards, Metal and Flexible.

1.30 SUBMITTALS

A. General: Comply with Section 01330.
B. Product data: Each type of duct accessory included in the project.

1. Include manufacturer’s written installation instructions for each type of fire damper.
C. Shop drawings: Detail equipment assemblies and indicate dimensions, loadings, required clearances, method of field assembly, components, locations, and size of each field connection. Detail these accessories:

1. Special fittings and manual and automatic volume damper installations.

D. Certifications: Certified test data for dynamic insertion loss; sound power levels; airflow performance data, and static-pressure loss.

1.40 QUALITY ASSURANCE

A. Work of this section shall comply with NFPA 90A and 90B, and SMACNA HVAC DCS.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers' names and specific products are described in the articles below to set a standard for materials, quality of construction, options and details, and performance. Provide named products, or equal products by other named manufacturers.

2.10 MATERIALS

A. Sheet metal: As specified in Section 15810.


1. For use indoors: Equal to Ventfabrics "Ventglas," coated with polychloroprene (DuPont "Neoprene"), 30 ounces per square yard.

C. Bird screen: ASTM E 437, general industrial-use wire cloth, Grade C, medium light or heavier, nominal 0.5-inch (13-mm) mesh and 0.063-inch (1.6-mm) wire diameter, aluminum or stainless steel.

1. Frame: Removable, rewirable, of same material and finish as the duct or accessory to which it is installed.

2.20 MANUFACTURED UNITS

A. Instrument test holes for ductwork balancing stations: Equal to Ventfabrics "Ventlock" No. 699 or 699-2 as required for insulation thickness, with gasket for base, and threaded cap.

B. Air turning vanes: Double vane type, constructed in accordance with SMACNA HVAC DCS, from the same material as the duct.

2.21 DUCT ACCESS DOORS

B. Construction: Door and frame fabricated of 24 gauge galvanized steel, minimum size 16 inches (406 mm) by 16 inches (406 mm), or 16 inches (406 mm) by maximum duct size.

C. Door: Hinged with continuous piano hinge; number of cam latches to suit door size. Insulated doors shall be double pan construction, one inch (25 mm) thick with one inch (25 mm) thick minimum 3.5 pound (56 kg per cubic meter) density fiberglass insulation cut full to require forcing into the pan.

D. Gaskets: Continuous around perimeter, sealing frame to duct and door to frame, neoprene or foam rubber.

E. As an option, provide round access doors equal to Ventfabrics "Ventlok Twist-In" doors, complete with safety holding cable, 12 inches (305 mm) diameter.

2.22 SOUND ATTENUATORS

A. Manufactured by Dynasonic Systems, Inc., Semco, Rink Industrial Acoustics Company, or Commercial Acoustics Division of Metal Form Manufacturing; sizes and types shown and scheduled on the drawings. Field fabrication will not be permitted.

B. Materials: The entire attenuator shall be incombustible, moisture-resistant, and odorless.

1. Outer casings: 22 gauge galvanized steel, seams lock-formed.

2. Interior baffles: 22 gauge perforated galvanized steel.

3. Acoustical filler material: Fiberglass, packed under compression to 4.5 pound density.


D. Acoustical performance for duct-mounted units: Only tests made at an independent testing laboratory will be considered, and the test data must include acoustical performance and generated noise levels at various airflow velocities. Acoustical and pressure drop performance shall be as scheduled on the drawings.

1. Insertion loss: Measured by the "Duct to Reverberation Room" method, recommended by the SIW42 subcommittee of the American Standards Association (USASI), with airflow.

2. Generated noise: Measured in accordance with ASHRAE 36B Test Method.

E. The same test sample shall have been used for both acoustic and aerodynamic measurement.

2.25 DAMPERS

A. Manual volume dampers:

1. 13 inches (330 mm) and larger in height: Balanced multi-louver, opposed-blade type with maximum blade width of 6 inches (155 mm), equal to Ruskin MD 35/0B with PTFE-filled non-corrosive bearings and 0.375-inch (9.5-mm) control shaft; and with Young Regulator Co. Model No. 443B-3/8 damper regulators.
2. 12 inches (305 mm) or less in height: Fabricated from 16 gauge metal with hemmed edges, 0.375-inch (9.5-mm) square rod, Young Regulator Co. Model No. 443B-3/8 regulator and Model No. 429 FD end bearing.

2.70 ACCESSORIES

A. Duct clamps for flexible duct and flexible fabric connections: Positive locking drawbands able to conform to any shape. Fabricate from a single piece of galvanized steel, with zinc-plated steel screw and buckle. Equal to "59 Series" manufactured by Ideal Division, Parker Hannifin Corporation.

B. Instrument test holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness.

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Duct accessories shall be mounted or installed properly in accordance with the manufacturer's instructions and as indicated on the drawings.

3.21 INSTALLING CONNECTIONS AND SCREENS

A. Install in each duct connection to motor-driven equipment, and other locations where shown on drawings, a flexible fabric connection to prevent vibration being transmitted from equipment to ductwork. Securely clamp the cloth to the ducts and duct collars with duct clamps, providing 1 inch (25 mm) slack. Stitch seams with fiberglass thread.

B. Install bird screen in outside air connections.

3.22 INSTALLING MANUFACTURED UNITS

A. Provide necessary devices to balance the air flow to produce air quantities at outlets as indicated on the drawings.

B. Provide balancing point stations and where required for air balancing. Coordinate work with requirements of Section 15950, Testing, Adjusting, and Balancing; final locations shall be as directed by the balancing and testing subcontractor. Stations shall consist of test holes spaced 6 inches (150 mm) on centers across bottom or side of duct. Install test holes before ducts are insulated.

C. Provide turning vanes in 90-degree square elbows.

D. Installing duct access doors:

1. Install duct access doors in ductwork for access to fire dampers, ATC dampers, controls, control devices, and any other devices, equipment, or components requiring maintenance, service, or adjustment and located inside ducts or adjacent equipment.

2. Provide OSHA-approved labels on doors enclosing fire protection devices. Labels shall have lettering at least 1/2 inch (13 mm) high describing the protection device enclosed.
E. Installing sound attenuator:

F. Installing air control devices:

1. Install manual volume dampers and other devices at locations indicated on drawings and where required to properly balance the systems and to deliver the air quantities indicated. Each damper and device shall have substantial operators of proper size with locking facilities. Volume dampers shall be equipped with locking type regulators.

2. Install automatic control dampers.

END OF SECTION
PART 1 - GENERAL

1.10 SUMMARY

A. Filters for temporary service during construction are required in the equipment sections.

B. Provide two sets of filters for every item of equipment requiring filters, as follows:
   1. Filters for regular service, installed before air balancing.
   2. Filters for regular service, provided as extra materials for future use.

1.14 RELATED SECTIONS

A. Air-handling units with coils: Section 15721

B. Fan coil units: Section 15763

C. Unit heaters: Section 15768

1.20 REFERENCES

A. ASHRAE 52.1: Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter.

B. ARI 850: Commercial and Industrial Air Filter Equipment.

1.21 DEFINITIONS

A. Temporary service: Operation of equipment during the construction period, before air balancing.

B. Regular service: Operation of equipment during air balancing and in normal use during occupancy.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data: For filters, include filter efficiency, rated flow capacity, and fire classification.

C. Closeout submittals: As required for Operating and Maintenance Manuals in Section 01770, provide a schedule of locations of filters, identifying equipment and filter types and sizes, including prefilters and final filters.

1.40 QUALITY ASSURANCE

A. Provide all filters for regular service from a single manufacturer.

B. Test filters by methods described in ASHRAE 52.1.

C. Comply with ARI 850.
1.92 EXTRA MATERIALS

A. Disposable and throwaway filters: For each filter included for regular service, provide one extra filter. Identify each filter with its name and intended location and use.

B. Provide filters and media in protective packaging, with identifying labels or markings.

C. Except as otherwise required in Division 1, deliver to location designated by Owner, and shelve or stack as directed.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The listed manufacturers and particular products are intended to set a standard for materials, composition, and performance. Products of other manufacturers may be proposed as permitted by the provisions of the article "Product Options" in Section 01600.

1. Filters and filter-holding systems:
   - AAF International
   - Continental Air Filter (Div. NiCon Filter Corp)
   - Farr Company
   - Flanders Filters, Inc.

2. Filter gauges:
   - Dwyer Instruments, Inc.
   - Weksler Instrument Corporation

2.20 FILTERS, GENERAL

A. Coordinate with approved manufacturers of the various approved air handling units and equipment for filter size and thickness required.

B. Thickness: Generally, large air handling units shall have two-inch thick filters. Smaller units such as cabinet unit heaters shall have filters of special sizes and shapes, 0.5 inch and 1 inch thick.

C. Filter face areas: As scheduled, or equivalent to one square foot for each 300 cfm.

2.21 THROWAWAY FILTERS

A. FS F-F-310, Type I throwaway frame and media, Grade B high dust holding capacity, of size and thickness to fit units.

2.22 DISPOSABLE MEDIUM-EFFICIENCY FILTERS, 30 PERCENT

A. Farr 30/30, Class 2, thickness and size required for each location, disposable.

B. Rating in accordance with ASHRAE 52.1:
   1. Average efficiency: 25 to 30 percent.
   2. Average arrestance: 90 to 92 percent.
C. UL rating: Class 2.

D. Medium: Non-woven, reinforced cotton and synthetic fabric, minimum thickness 0.15 inch, weight 2.5 ounces per square yard, pleated.

E. Medium support grid: Welded wire with an effective open area not less than 96 per cent, bonded to medium.
   1. Performance: Medium shall not oscillate nor pull away from support grid.
   2. Design: Tapered radial pleats, supporting medium both vertically and horizontally.

F. Enclosing frame: High-wet-strength beverage board, with diagonal supports bonded to media pleats. Filter pack continuously bonded to inside of frame so that no air leaks around edges.

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Before startup of each item of equipment requiring a filter, install filters for temporary service.
   1. Generally, provide throwaway filters for temporary service.
   2. On equipment with prefilter and final filter, provide only the specified prefilter for temporary service.

B. Immediately prior to air balancing, remove temporary filters and install filters required for regular service.

END OF SECTION
SECTION 15901

AUTOMATIC TEMPERATURE CONTROL SYSTEM

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Complete new automatic temperature control (ATC) system.

B. Sequence of operation for automatically controlled equipment is shown on drawings. ATC subcontractor shall cooperate with the unit suppliers and provide all relays and wiring required to integrate the sequence of operation.

1.12 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Automatic control valves and insertion wells in piping: For installation under Section 15180.

B. Dampers: For installation under Section 15810.

1.13 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Duct smoke detectors: Section 13851.

1.14 RELATED SECTIONS

A. Controls: Sections 15901 through 15910.

B. Balancing: Section 15950.

1.25 SYSTEM DESCRIPTION

A. Provide a complete system of direct digital temperature controls with electronic and electric actuation.

B. The system shall consist of two levels of network communication and wiring. DDC controllers, application-specific controllers, software, operator I/O devices, sensors and other necessary input hardware, dampers, valves, actuators and other necessary output hardware, fire and smoke devices, electrical power surge protection, other necessary equipment and a complete system of wiring to fulfill the intent of the sequences of operation shown on the drawings.

1.26 DESIGN REQUIREMENTS:

A. The products specified, scheduled, and shown on drawings are the basis of the design of this project.

B. For requirements affecting use of optional manufacturers, or substitutions, see Section 01600, Product Requirements, and Section 15050, Basic Mechanical Materials and Methods.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Shop drawings: Provide a point schedule and composite control diagram of all equipment provided for each control sequence, including factory and field controls. Include a written
description of sequences, in which each control device or item of equipment is identified by the
designation indicated on the diagram.

C. Product data: See individual controls sections.

D. Certifications:
   1. Factory authorization and certification of the installing company.
   2. Evidence of training, and certification of each supervisor and mechanic assigned to this
      project.

E. Project record documents: As specified in Section 01770, provide a drawing at the same scale
   as the contract drawings, showing the locations of all components installed.

1.40 QUALITY ASSURANCE

A. Subcontractor qualifications: One hundred percent company-owned, full-service, local branch
   or authorized factory-direct contractor for one of the acceptable national temperature control
   manufacturing companies named below, as follows:
      1. Full service: Includes system engineering, shop drawing preparation, software
         programming, installation, commissioning, and service.
      2. Factory-direct contractor: Is contracted directly with manufacturer to buy components and
         has direct access to manufacturer's local branch office for engineering, service, and technical
         support without any third-party involvement.
      3. Experience: The branch or factory-direct contractor shall have completed at least three
         system installations of the same type, size, and design, which have successfully operated
         their sequence of operations for at least three years.
      4. Supervisors and mechanics: Factory-trained and certified in the type of control system
         (pneumatic, electric, digital, electronic) being installed, and directly employed by the
         subcontractor.
            a. The programmer responsible for programming digital controllers shall have a
               minimum of three years' experience programming digital controllers of the
               manufacturer, for HVAC systems.

B. Qualified subcontractor shall prepare control diagrams.

C. Perform work in accordance with the plumbing, electrical, building, fire and safety codes of the
   state, county, or city in which the work is performed.

D. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical
   Materials and Methods.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Electric, electronic, or direct digital system:
   American Automatrix by TFC Automation
PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Coordinate with equipment suppliers to integrate controls provided by manufacturers into the control sequences shown on drawings.

B. Mount devices and control panels provided by equipment manufacturers, and provide required control wiring.

C. Operate, test, calibrate, and adjust each control system until it operates as intended by the manufacturer and as specified in the control sequence.

3.61 TESTS

A. Thoroughly test and check the completed system to ascertain that all equipment is functioning as intended and that dampers and valves respond properly to their controls. Installer of work of this section shall cooperate with the equipment suppliers, and with balancing and testing work, to make necessary adjustments to ATC devices for proper operation of the completed system.

3.81 OPERATING INSTRUCTIONS

A. As specified in Section 15050, provide operating instructions.

B. Provide at least eight hours of additional instruction time for the system specified in this section, consisting of two periods of 4 consecutive hours, separated by at least 30 days.

END OF SECTION
SECTION 15902
CONTROL WIRING

PART 1 - GENERAL

1.11 SECTION INCLUDES
   A. Wiring for automatic temperature control system.

1.14 RELATED SECTIONS
   A. Automatic temperature control system: Sections 15901 through 15910.
   B. Control sequences: Shown on drawings.

1.30 SUBMITTALS
   A. General: Comply with Section 01330.
   B. Product data: Wire, cable, conduit and fittings, disconnecting switches, and transformers.

1.40 QUALITY ASSURANCE
   A. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical Materials and Methods.
   B. ATC circuit shall not supply other building components such as lights or receptacles.

PART 2 - PRODUCTS

2.10 MATERIALS, GENERAL
   A. Electrical materials and devices shall be UL listed and shall meet the requirements of NEC (NFPA 70) and Division 16, Electrical.

2.21 WIRING
   A. Wiring 50 V and below: Fully color coded, copper 600 V type THW or THHN, minimum No. 22 or as specified in Division 16, Electrical.
   B. Wiring above 50 V: As specified in Section 16120, Wires and Cables.

2.22 CONDUIT AND FITTINGS
   A. Galvanized steel conduit: Minimum size 0.5 inch, hot-dip galvanized with threads galvanized after cutting, one of the following:
      1. Rigid full weight, heavy-wall steel conduit (RGS) conforming to UL 6 and ANSI C80.01.
      2. Intermediate steel conduit (IMC) conforming to UL 1242 and ANSI C80.03.
   B. Steel conduit fittings: Cast malleable iron fittings with smooth finish and full threaded hubs. Include steel or malleable iron locknuts, bushings, and other fittings.
      1. Insulating bushings: Equal to Thomas and Betts Series 22.
2. Hub fittings with recessed sealing ring and nylon insulated throat equal to Thomas and Betts Series 370.

3. Fittings for exposed locations: Conduit outlet bodies, zinc- or cadmium-plated.

C. Electrical metallic tubing (EMT): Minimum size 0.5 inch (16 mm), maximum 1.5 inch (41 mm), hot-dip galvanized or sherardized thin-wall steel conduit conforming to UL 797 and ANSI C 80.03.

D. Connectors and couplings for EMT: Concrete- or rain-tight, compression or set screw type, made of cadmium-plated steel with nylon insulating throat, equal to Thomas & Betts Series 5031, 5123 and 5120.

E. Flexible metal conduit: Minimum size 0.5 inch (16 mm), made of sheet metal strip, interlocked construction, conforming to UL 1.

F. Liquidtight flexible metal conduit shall conform to UL 360.

G. Connectors for flexible metal conduit: Equal to angle wedge "Tite-Bite" with nylon insulated throat, Thomas & Betts Series 3110 and 3130.

H. Liquidtight connectors: UL 14814A, with fittings and nylon-insulated throat, equal to Thomas & Betts Series 5331.

I. Surface metal raceway: Equal to Wiremold No. 500 minimum size, complete with fittings, connectors, and accessories.

2.30 EQUIPMENT

A. Control transformer: Designed for power sources for 24-V ac control circuits, and precision built to ensure rated power, proper voltage regulation and maximum efficiency. Units shall be equipped with integral manual reset circuit breaker for over-current protection on the secondary winding. Output regulation shall be 10 percent from no load to full load.

B. Disconnecting switches: Specified in Section 16170.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Electrical equipment is specified in Division 16, Electrical. Include in the work of this section relays, pushbuttons, transformers, coils, wiring or other equipment, meeting requirements of Division 16, so that the automatic temperature control system will function as intended.

B. Install conduit and wiring as specified in Sections 16120 and 16131.

C. Make each run of cable or conductor connecting two points with a single continuous piece of cable or conductor. Do not splice. Cable or conductor may be extended by use of suitable connectors if approved by the Engineer.

D. When connecting to electrical wiring of equipment provided with pilot lights, connect to circuit so that pilot light is only energized when equipment is energized.

E. Where necessary to connect conduit to motors or motor driven equipment, or to attach conduit to fan housings or air-handling units which contain fans, use a 24-inch (610-mm) looped section of flexible metallic conduit.
F. When connecting to electric wiring of exhaust fans with hand/off/automatic (HOA) switches and exhaust dampers, connect to circuit so that damper opens in both hand and automatic positions.

G. Securely attach disconnects and starters to the wall with lead anchors.

H. Provide dedicated 120-V power service to each terminal unit that does not already have electric connections for fan or electric heater.

END OF SECTION
SECTION 15904
CONTROL DEVICES

PART 1 - GENERAL

1.11 SECTION INCLUDES

   A. Control devices and accessories.

1.12 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

   A. Wells: Section 15180.

1.13 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

   A. Duct-mounted smoke detectors: Section 13851.

1.14 RELATED SECTIONS

   A. Automatic temperature control system: Sections 15901 through 15910.

   B. Sequence of operations: Shown on drawings.

1.30 SUBMITTALS

   A. General: Comply with Section 01330.

   B. Shop drawings:

      1. Each control device labeled with setting or adjustable range of control.

      2. Wiring diagrams. Differentiate between factory-installed and field-installed wiring.

   C. Product data:

      1. For each device, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes, and installation instructions.

      2. Each type of accessory. Include finishes.

   D. Maintenance data: As required in Section 01770, Closeout Procedures.

1.92 EXTRA MATERIALS

   A. Provide two sets of manufacturer's special tools for operating tamperproof fasteners, marked to identify their use.

   B. Deliver to Owner's designated storage area and store as directed.

PART 2 - PRODUCTS

2.10 CONTROL DEVICES, GENERAL

   A. Instruments with predetermined temperature or pressure setpoints shall be provided with a means of adjustment over a reasonable range. Adjustable devices for control of temperatures
A. Each room temperature sensor shall include a setpoint adjustment dial, a temperature indicator, an override switch, and a terminal jack.

1. The setpoint adjustment dial shall allow for modification of the temperature by the occupant. Setpoint adjustment may be locked out, overridden or limited as to time or temperature through software by an authorized operator.

2. The temperature indicator shall be digital readout and shall be visible without removing the sensor cover.

3. The override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant. The override function may be locked out, overridden or limited as to the time through software by an authorized operator.

4. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller.

5. Provide controller to accommodate sensor type. Provide room temperature sensors closely matched to the requirements of the associated controllers. Signal input and output shall be accurate, responsive, and silent. The sensor may be either RTD or thermistor type providing the following minimum performance requirements are met:

   - **Accuracy:** plus or minus 1 degree F (0.6 degrees C)
   - **Operating range:** 35 to 115 degrees F (2 to 46 degrees C)
   - **Set point adjustment range:** 55 to 95 degrees F (2 to 30 degrees C)
   - **Set point modes:** Independent Heating, Cooling, Night Setback-Heating, Night Setback-Cooling
   - **Calibration adjustments:** None required
   - **Installation:** Up to 100 feet from controller

B. Sensors installed in pipes shall be installed in thermometer wells of bronze or stainless-steel materials. Heat transfer compounds shall be compatible with the sensor. Compression type fittings between sensors and thermometer wells are not acceptable.

C. Temperature sensors for air systems shall be RTD type. Sensors shall have a time constant response of less than 3 seconds to a temperature change of 1 degree. Sensors shall be coupled with industrial grade adjustable span transmitters to achieve the following range with the accuracy specified: 10 to 100 degrees F, plus or minus 1 degree F. Sensors shall be suitable for insertion into air ducts and have a minimum insertion of 6 inches.
D. Differential pressure sensors: Pressure sensors shall have adjustable high and low limits and be suitable for operation in an ambient temperature range of 30 to 140 degrees F. Accuracy shall be within one percent of full scale. Operating range shall be adjustable. Provide three valve manifolds for isolation.

E. Freezestats: Freezestats shall have 20 foot element and adjustable setpoint.

2.14 AUXILIARY CONTROLS

A. Manual push buttons for smoke exhaust: Momentary contact switch to make an electric circuit when depressed and break a circuit when released.

B. Emergency fan disconnecting switch:

1. Switch: Security type, operated by a keyed lock, equal to Pass and Seymour 20AC-KL. Provide complete with stainless-steel device plate and two keys.

2. Key box: Break-glass enclosure, approximately 6 by 7 inches, red enameled steel or molded polycarbonate, with glass inscribed "Break Glass". Where installed on exterior wall, provide neoprene gasket. Mount with tamperproof screws.
   a. Key hook attached to inner frame.
   b. Glass breaker attached to frame.

3. Key: Same key operates switch and opens box.

4. Provide two extra replacement glasses.

5. Operation: Deenergizes the air-handling units when indexed to the off position.

6. Instructions: Emergency sign, operating instructions, and laminated plastic nameplate, white letters on black background, text shown on drawings.

2.70 ACCESSORIES

A. Guards for wall-mounted thermostats: Cast aluminum of minimum thickness 0.14 inch. Polycarbonate sheet or punched sheet metal guards are not acceptable.

1. Option: Shaw Perkins Inc. Series 16 thermostat guard fabricated from 16 gauge perforated steel (0.125-inch perforations on 0.187-inch staggered centers) and 14-gauge solid steel mounting frame finished in "cool tan" baked enamel.

B. Security fasteners for thermostats and guards: Equal to stainless-steel "Tampruf" as manufactured by Jefferson Screw Corp. Provide two sets of special tools as required in Part 1 above.

C. Plastic nameplates: As specified in Section 15050, Basic Mechanical Materials and Methods, minimum plate size 0.75 by 2.5 inches, minimum letter size 0.1875 inch, properly identifying equipment and use.

PART 3 - EXECUTION

3.20 INSTALLATION
A. Where averaging type bulbs or tubing and low temperature protection thermostats are installed within ductwork or unit casings, provide a removable galvanized frame with 1-inch square mesh wire for attaching the tubing in desired pattern. Where capillary passes through duct side or unit casing, provide split flange fitting to seal hole and protect the capillary in the duct or casing.

B. Instruments mounted on insulated ducts or equipment shall have mounting brackets arranged to permit full insulation on the duct.

C. Room thermostats mounted in unit casing or on sampling chamber shall not be an acceptable substitute for insertion thermostats.

D. One pipe transmitters may be used in insertion and immersion thermostat applications only as a sensing element for a receiver-controller.

E. Bulbs for outdoor air thermostats shall be shielded from the sun and reflected heat rays. These bulbs may be located behind weather louvers of OA intakes but ahead of any ATC damper.

F. Thermostats: Mount on wall or fan-coil unit casing, securely anchored. Mounting height from floor to top of thermostat shall be 48 inches, as required for accessibility to persons using wheelchairs.

G. Mount thermostats with tamperproof screws, on 14-gauge steel plates 4 by 6 inches over existing thermostat locations and securely anchored into the wall. Where thermostats are located in new locations, use wall boxes securely anchored flush into the wall. Use copper tubing from ceiling to thermostat either fished through wall cavity or chased into wall and patched to match existing surface. Use Wiremold to run around ceiling for inaccessible ceilings or concealing accessible ceiling.

H. Provide guards for wall-mounted thermostats where noted on drawings.

1. Mount guard base to the steel plate or wall by at least four tamperproof screws, entirely independent of thermostat wall plate and cover.

I. Provide manual override on thermostats as noted in sequence of operation.

J. Mount thermostats in toilet areas 84 inches above finished floor.

K. Where thermostats are removed and not replaced, seal ends of tubing or wiring and push back into wall.

1. On glazed surfaces, provide blank cover plates.

2. On other surfaces, patch in accordance with requirements of Section 01045, Cutting and Patching.

L. Provide manual smoke exhaust pushbuttons on systems with smoke detectors inside ductwork, which when depressed will bypass the smoke detectors, open OA dampers 100 percent, close RA dampers and energize the fan to exhaust smoke from ductwork. Pushbutton shall not bypass freeze detectors or other safety controls. When released, system shall return to normal sequence operation. Button may be mounted on control panel or mechanical room cabinets. Provide laminated plastic nameplate entitled “MANUAL SMOKE EXHAUST - AHU #_____”.

M. Emergency fan disconnect switch: Install in location approved by fire marshall.

3.21 INSTALLING DIGITAL CONTROLLER
A. Provide wiring required between digital controller and equipment as scheduled on the Control Point Schedule.

B. Cooperate with Owner to set up the digital controller to operate as shown in sequence of operations on the drawings.

END OF SECTION
SECTION 15905

CONTROL PANELS

PART 1 - GENERAL

1.11 SECTION INCLUDED

A. Control panels and accessories.

1.14 RELATED SECTIONS

A. General information: Section 15901.

B. Control sequences: Shown on drawings.

1.30 SUBMITTALS

A. General: Comply with Section 01300.

B. Product data: Each type of control panel included in the project.

C. Shop drawings: Front elevation of each control panel, drawn at a scale of 0.5 inch equals one foot.

D. Samples: Color chips, showing complete line of colors and textures.

1.40 QUALITY ASSURANCE

A. UL label and local testing (if required): As specified in Section 15050, Basic Mechanical Materials and Methods.

B. Do not begin fabrication of control panels until shop drawings have been approved.

PART 2 - PRODUCTS

2.31 OCCUPIED - UNOCCUPIED CONTROL PANELS

A. Construction: No less than 16 gauge steel sheet, with corners riveted to internal steel angle brackets.

1. Mounting panels: Front and back, aluminum bonded to both sides of a marine plywood core.

2. Door: Full size of cabinet, overlapping its frame on all four sides, with continuous piano hinge. Include a key-locked latch and two keys.

3. Legs: Square tubular steel.

4. Finish: Complete interior and exterior, manufacturer's standard industrial enamel finish system, color to be selected from manufacturer's standard colors.

B. Equipment: Switches, relays, programmable controls, occupied/unoccupied selector switches, and other components required to accomplish the control sequences. Switches and instruments for each system shall be neatly grouped and separate from equipment and instruments of other systems.
2.33 MECHANICAL ROOM CABINETS

A. Provide enclosed, lockable, 16 gauge steel cabinets, one located in each mechanical equipment room, which shall contain all controls which are not required to be mounted at the controlled device. Manual switches and indicating gauges for each switch shall be mounted inside the cabinet. Wiring in the panel shall be color-coded, and wiring shall be extended to numbered terminal strips.

PART 3 - EXECUTION

3.20 INSTALLATION, GENERAL

A. Panels mounted on legs shall have the legs securely attached to floor with 0.25 inch lead anchors. Provide a 4-inch-high concrete base around legs and conduits leaving the panel where conduits pass into floor.

B. Panels attached to walls shall be secured with toggle bolts or lead anchors as required. Anchor plates shall be built into walls for large surface-mounted units.

END OF SECTION
SECTION 15907
CONTROL DAMPERS

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Dampers for automatic control.

1.12 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION;

A. Dampers: Install under Section 15810.

1.14 RELATED SECTIONS

A. Smoke detectors: Section 13851.

B. Ductwork: Section 15810.

C. Control system, general: Section 15901.

D. Control sequences: Shown on drawings.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data, including test data and ratings, for each type of damper and operator included in the work.

PART 2 - PRODUCTS

2.21 CONTROL DAMPERS AND OPERATORS

A. Supply and return dampers: Equal to Ruskin Model CD35. Dampers for two-position control may be parallel blade type. Dampers for modulating control shall be balanced, multi-louver, opposed-blade type.


2. Frames: Dampers shall be mounted horizontally in a welded channel angle or flat steel frame filled with solid air-stops which shall prevent air leakage between frame and blades. Provide corner braces on frames that measure more than 24 by 24 inches (610 by 610 mm). Finish: two coats of black enamel.

3. Operation: Provide blades with brass pivots operating in non-stick, corrosion-resistant bearings securely mounted in damper frames. Hardware and operating linkage shall be brass or cadmium plated steel. Linkage shall be adjustable in length; joints shall be pin and clevis or ball and socket, free of excessive play. Dampers shall be capable of being positioned accurately from 100 percent open to 100 percent closed and of maintaining any given position indefinitely. Dampers requiring 100 percent closure shall have neoprene gasketed edges.
B. Outside air (OA), pressure relief (PR), and exhaust air (EA) dampers: Equal to Arrow United Industries, Inc. "Pin-Lock" No. OBDPL-507, extruded aluminum or steel frames and blades. Dampers sized on a velocity of 2000 fps shall have a maximum total leakage of 0.5 percent when closed against a 2-inch wg static pressure. Provide mechanically fastened neoprene or vinyl blade seals to fit integral ribbed groove inserts in both frame and blade. Seals that are fastened to blades or frame by adhesive will not be acceptable. Maximum blade width shall be six inches.

C. Electric damper operators: Electric motor type with opening time of at least 30 seconds, of size to have 50 percent more power than the minimum required to operate the damper. Fail safe in the event of loss of power. Fresh air and exhaust air dampers shall close and return air dampers shall open.

PART 3 - EXECUTION

3.20 INSTALLATION

A. Furnish dampers to be set in place under Section 15810, Ducts, under the supervision of the control subcontractor.

B. Install operators on control dampers. Operation of particular dampers in conjunction with operation of air-handling equipment is described in control sequences.

C. Set screws shall be set on a flat space on a round shaft. Provide a double set screw as a lock.

END OF SECTION
SECTION 15908
CONTROL VALVES

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Automatic control valves, actuators, and accessories.

1.12 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Control valves: Section 15180.

1.14 RELATED SECTIONS

A. Control system, general: Section 15901.

B. Control sequences: Shown on drawings.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Product data: Valves, devices, and actuators, each type included in project.

PART 2 - PRODUCTS

2.21 CONTROL VALVES

A. Two-way and three-way valves shall be sized by the control subcontractor and guaranteed to be of sufficient size to meet the heating or cooling requirements.

B. With no electric power on the valve actuator, valve shall be in the normal position determined by the application.

1. Unless indicated otherwise, heating system valves are normally open.

2. Cooling valves and valves for domestic water heat exchangers are normally closed.

C. Valves NPS 2 (DN 50) and smaller: Single-seated globe or union globe type with an equal percentage flow characteristic valve plug, capable of handling water at a maximum 150 psig (1035 kPa), 281 degrees F (138 degrees C). Valves shall have threaded ends.

1. Bodies: Cast brass, rated at 150 psig (1035 kPa).

2. Trim: Brass.

3. Stem: Stainless steel, with replaceable composition disk seat. The stem packing shall be synthetic elastomer U-copper type, utilizing the system pressure to prevent packing leaks.

D. Valves NPS 2.5 (DN 65) and larger: Single-seated with equal percentage flow characteristic valve plug.

1. Bodies: Cast iron, rated 150 psig (1035 kPa).
2. Trim, stem, replaceable disk, and stem packing: The same as the smaller valves.

E. Three-way valve: Mixing or diverting for modulating or two-position control of the direct-or reverse-acting type with maximum operating temperature of 250 degrees F (121 degrees C).

1. Bodies: Brass or bronze, rated at 150 psi (1034 kPa), with threaded end connections or cast iron rated at 150 psi (1034 kPa) with flanged end connections.

2. Trim: Bronze or brass.

3. Stem: Stainless steel with replaceable bronze or brass seat. The stem packing shall be silicone U-copper Teflon V ring.

F. Butterfly valves: Two-way or three-way modulating for position control of the mixing or diverting applications. Three-way assemblies shall be assembled with two valves and a flanged cast-iron tee, or dual valve pipe assemblies. Valve body shall be supplied with stainless steel stem, bronze or steel disk and synthetic rubber seat. Valve shall be suitable for electric actuation. Valves shall be rated for 150 psi (1034 kPa) and 225 degrees F (107 degrees C).

G. Maximum pressure drop across water valves shall be 4.0 psi (28 kPa).

2.23 ELECTRIC VALVE OPERATORS

A. Low or line voltage electric or electronic motor type with minimum opening and closing time of 15 seconds, sized to provide sufficient power to operate the valve.

B. Solenoid valves (quick-closing) are not acceptable.

PART 3 - EXECUTION

3.21 INSTALLING VALVES

A. Install valves complete with operators, as indicated on drawings and as required by Control Sequences.

END OF SECTION
SECTION 15910
DIRECT DIGITAL BUILDING SYSTEMS CONTROL

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. Direct digital building control (DDC) system.
B. Network communications
C. DDC panels
D. System software
E. Application-specific controllers
F. Operator I/O devices

1.14 RELATED SECTIONS

A. Coordination, installer qualifications, and acceptable manufacturers: Section 15901.
B. Automatic temperature control system: Sections 15901 through 15910.
C. Control sequences: Shown on drawings.

1.30 SUBMITTALS

A. General: Comply with Section 01330.
B. Installer qualifications: Submit as required in Section 15901, Automatic Temperature Control System. Include, in addition to other requirements, the location of the support facility from which warranty and service will be provided, and a list of the names, titles, and training of the individuals who will be responsible for the work of this project.
C. Documentation: Submit complete documentation for the system hardware and software, including user's manuals and other support sufficient to enable Owner's personnel to understand and correctly operate the system. Include this documentation in Operation and Maintenance submittals in accordance with Section 01770.
D. Certifications:
   1. Data sheet or copy of government approval form showing that the system complies with FCC Regulations, Part 15, Section 15.
   2. Results of functional and diagnostic field tests and calibrations, specified in Part 3.
   3. Submit Compliance Inspection Checklist, initialed and dated, showing satisfactory completion of the installation tests specified in Part 3.

1.90 WARRANTY AND SERVICE

A. General requirements: Provide all services, materials and equipment necessary for the successful operation and maintenance of the entire DDC system for the period of the general
project correction period required by General Conditions, Division 1, and Section 15010. Provide parts, software, and labor required for the work. Schedule maintenance and adjustments to minimize effects on facility operations.

B. The adjustment and repair of the system includes computer equipment, software updates, transmission equipment, and sensors and control devices. Provide the manufacturer's required adjustments and other work necessary to maintain system operation.

C. Personnel: Provide qualified personnel to accomplish work promptly and satisfactorily. Notify Owner in writing of the name of the designated service representative, and of changes in personnel.

D. Schedule of work: Schedule major inspections in June and December and minor inspections in March and September. Minor inspections shall include visual checks and operational tests of each item of equipment. Major inspections shall include all work described for minor inspections and the following work:

1. Clean equipment, including interior and exterior surfaces.
2. Perform signal, voltage, and system isolation checks of system workstations and peripherals.
3. Check and calibrate each field device. Check all analog points and digital points.
4. Run diagnostics and correct diagnosed problems.
5. Resolve and correct other observable problems.

E. Emergency service: Qualified personnel shall be available to provide service to the complete system. Furnish owner with a telephone number where service representative can be reached at all times. Service personnel shall be at the site within 8 hours after receiving a request for service, and shall restore the control system to proper operating condition within 24 hours.

F. Operation: Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the initial performance test.

G. Systems modifications: Make recommendations for system modification in writing to Owner. Do not make any system modifications, including operating parameters and control settings, without prior written approval of Owner. Modifications to the system shall be incorporated into the operations and maintenance manuals and other documentation.

H. Software: During the project correction period, provide all software updates and verify operation in the system in a timely manner. Instruct the system operators, and incorporate updates into the operations and maintenance manuals and software documentation. At the end of the correction period, continue to notify Owner of software revisions.

PART 2 - PRODUCTS

2.30 GENERAL PRODUCT DESCRIPTION

A. The DDC system shall integrate multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection.

B. The building control system shall consist of the following:

1. Network DDC panels
2. Network application-specific controllers (ASCs)

3. A link to a personal computer operator workstation(s) already located on the UMBC campus and installation of operator workstation software on that workstation.

C. The system shall be modular and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC panels, application-specific controllers, and operator devices.

D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

E. Without depending on a control processing device, DDC panels shall be able to:
   1. Access any data from or send control commands and alarm reports directly to any other DDC panels or combination of panels on the network.
   2. Send alarm reports to multiple operator workstations.

2.31 NETWORKING COMMUNICATIONS

A. The DDC system shall network operator workstations.
   1. A high performance peer-to-peer network.
   2. An application-specific local area network (LAN).

B. Peer-to-peer network level:
   1. Operator workstations and DDC panels shall directly reside on a network such that communications shall be executed directly between DDC panels, directly between workstations, and between DDC panels and workstations on a peer-to-peer basis.

   2. Inherent in the system's design shall be the ability to expand or modify the network either via a LAN, or auto-dial telephone line modem connections, or via a combination of the two networking schemes.

   3. All operator devices, either network-resident or connected via dial-up modems, shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. Access to data shall be based on logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to the network data.

   4. Network design shall include the following provisions:
      a. Provide high-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. An alarm occurring at any DDC panel shall display at one or more workstations or alarm printers within 5 seconds.
      b. Support of any combination of DDC panels and operator workstations directly connected to the peer-to-peer network. The network shall support a minimum of 32 devices.
c. Message and alarm buffering to prevent information from being lost.

d. Error detection, correction, and retransmission to guarantee data integrity.

e. Synchronization of real-time clocks, to include automatic daylight savings time updating among all DDC panels.

f. Commonly available, multiple source, networking components and protocols shall be used to allow the DDC system to coexist with other networking applications such as office automation. ETHERNET and ARCNET are acceptable technologies.

g. Use of an industry standard IEEE 802.x protocol. Communications must be of a deterministic nature to assure calculable performance under worst-case network loading.

C. Application-specific local area network (LAN):

1. This level communication shall support a family of application-specific controllers and shall communicate bidirectionally with the peer-to-peer network through DDC panels for transmission of global data.

2. Application-specific controllers shall be arranged on the LANs in a functional relationship with DDC panels. For example, a VAV terminal unit controller shall be on a LAN from the DDC panel that is controlling its corresponding AHU.

3. A maximum of 32 application-specific controllers may be configured on each LAN.

D. Telecommunication capability:

1. Auto-dial/auto-answer communications shall allow DDC panels to communicate with remote operator stations and remote terminals via telephone lines, as indicated in the sequence of operations.

2. Auto-dial DDC panels shall automatically place calls to workstations to report alarms or other significant events.

3. Operators at the dial-up workstation shall be able to perform all control functions, all report functions and all database generation and modification functions as described for workstations connected via the network. Routines shall automatically answer calls from remote DDC panels. The fact that communications are taking place with remote DDC panels over telephone lines shall be invisible to an operator.

4. Dial-up communications shall use Hayes compatible modems, rated at 56 K, and voice-grade telephone lines.

2.32 DDC Panel

A. Microprocessor-based panels with a minimum word size of 16 bits: Multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Each DDC panel shall be capable of operating as a stand-alone controller, performing its specified control functions independently of other controllers in the network. Controller size shall be sufficient to fully meet the requirements of this specification and the point list on the drawings.

B. Each DDC controller shall have sufficient memory, a minimum of 1 megabyte, to support its own operating system and databases, including:
1. Control processes

2. Energy management applications

3. Alarm management applications

4. Historical and trend data for points specified

5. Maintenance support applications

6. Custom processes

7. Operator I/O

8. Dial-up communications

9. Manual override monitoring

C. Each DDC panel shall support:

1. Monitoring of the following types of inputs, without the addition of equipment outside the DDC panel:
   a. Analog inputs
      (1) 4-20 mA
      (2) 0-10 Vdc
      (3) Thermistors
      (4) 1000-ohm RTDs
   b. Digital inputs
      (1) Dry contact closure
      (2) Pulse accumulator
      (3) Voltage sensing

2. Direct control of pneumatic and electronic actuators and control devices. Each DDC panel shall be capable of providing the following control outputs without the addition of equipment outside the DDC panel:
   a. Digital outputs
      (1) Contact closure (motor starters, sizes 1-4)
   b. Analog outputs
      (1) 0-20 psi
      (2) 4-20 mA
      (3) 0-10 Vdc

D. Additional space for future point connections, each DDC panel: Minimum 10 percent.

1. Provide sufficient internal memory for the specified control sequences with at least 25 percent of the total memory available for future use.
E. Each DDC panel shall have at least two RS-232C serial data communication ports for operation of operator I/O devices.

F. Each DDC panel shall have point discrete, on-board, limited access hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points. These override switches shall be operable whether the panel processor is operational or not. DDC panels shall monitor the status of all overrides and remotely report each override control operation.

G. DDC panels shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.

H. Each DDC panel shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components, and provide both local and remote annunciation of detected component failures, low battery conditions, or repeated failure to establish communication.

I. Provide isolation at each peer-to-peer network termination and each field point termination, to suppress induced voltage transients, meeting requirements of IEEE C62.41.

J. In the event of the loss of normal power, each DDC panel shall shut down in an orderly process which shall prevent the loss of database or operating system software. Provide nonvolatile memory for critical controller configuration data and battery backup sufficient to support the real-time clock and volatile memory for a minimum of 72 hours.

1. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

2. Should DDC panel memory be lost for any reason, reloading the DDC panel shall be possible via the local RS-232C port, via telephone line dial-in, or from an operator workstation.

K. Provide a DDC panel for each AHU or other HVAC system as indicated on the drawings. It is intended that each unique system be provided with its own point-resident DDC panel.

2.33 SYSTEM SOFTWARE

A. General:

1. Provide all necessary software to form a complete control system as described in this specification.

2. The software programs specified in this section shall be integral in DDC panels and shall not be dependent upon any higher-level computer for execution.

B. Control software:

1. The DDC panels shall have the ability to perform the following pre-tested control algorithms:

   a. Two-position control

   b. Proportional control

   c. Proportional plus integral control
d. Proportional, integral, plus derivative control

e. Control loop tuning

2. Include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

3. Shall protect against excessive demand during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

4. Upon the resumption of normal power, the control software shall analyze the status of controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operations.

C. DDC panels shall be able to perform any or all of the following energy management routines:

1. Time-of-day scheduling

2. Calendar-based scheduling

3. Holiday scheduling

4. Temporary schedule overrides

5. Start-stop time optimization

6. Automatic Daylight Savings Time switchover

7. Night setback control

8. Enthalpy switchover (economizer)

9. Peak demand limiting

10. Temperature-compensated duty cycling

11. Fan speed/CFM control

12. Heating/cooling interlock

13. Cold deck reset

14. Hot deck reset

15. Hot water reset

16. Chilled water reset

17. Condenser water reset

D. DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. It shall be possible to use any of the following in a custom process:

a. Any system measured point data or status
b. Any calculated data
c. Any results from other processes
d. User-defined constants
e. Arithmetic functions (+, -, *, /, square root, exp, etc.)
f. Boolean logic operators (and/or, exclusive or, etc.)
g. On-delay/off-delay/one-shot timers

2. Custom processes may be triggered based on any combination of the following:
   a. Time interval
   b. Time of day
   c. Date
   d. Other processes
   e. Time programming
   f. Events (e.g., point alarms)

3. The custom control programming feature shall be documented in English.

E. Alarm management shall monitor and direct alarm information to operator devices. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to noncritical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by operation of a PC workstation or local I/O device, or by communications among panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

2. The user shall be able to define the specific system response to alarm at each point. Alarms shall be prioritized. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

3. Alarm reports and messages shall be directed to a user-defined list of operator devices.

4. In addition to the point's descriptor and the time and date, the user shall be able to print, display, or store an alarm message to more fully describe the alarm condition or direct operator response.

5. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.

F. A variety of historical data collection utilities shall manually or automatically sample, store, and display system data for points as specified in the I/O summary.
1. DDC panels shall store and report point history data for selected analog and digital inputs and outputs. Methods of collection shall be either by a predefined time interval or upon a predefined change of value.

2. DDC panels shall provide high resolution sampling for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary. Provide capability to view or print trend and tuning reports.

G. DDC panels shall automatically accumulate and store run-time hours for digital input and output points as specified in the point I/O summary.

H. DDC panels shall automatically sample, calculate, and store consumption totals on a daily, weekly or monthly basis for user-selected analog and digital pulse input type points as specified in the point I/O summary.

I. DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis for points as specified in the point I/O summary.

2.35 APPLICATION-SPECIFIC CONTROLLERS (ASC)

A. Each DDC panel shall be able to extend its performance and capacity through the use of remote application-specific controllers (ASCs).

B. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

C. Terminal equipment controllers:

1. System shall control each piece of equipment through direct connection to a DDC or ASC. Terminal equipment shall include, but not be limited to, the following:
   a. Unit conditioners (fan-coil units, induction units, pressure-dependent terminal units)
   b. Unit ventilators

2. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. As a minimum, 50 percent of the point outputs (except for unit ventilator controllers) shall be of the universal type, either modulating or two-position. Terminal equipment controllers utilizing proprietary control signals and actuators shall not be acceptable. Provide DDC panels or ASCs with industry standard outputs for control of terminal equipment.

3. Each controller shall perform its primary control function independent of other DDC panel LAN communication, or if LAN communication is interrupted. The controller shall receive its real-time data from the DDC panel time clock and shall ensure LAN continuity. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via terminals as specified herein.

4. Provide each terminal equipment controller with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in nonvolatile EEPROM, EPROM and PROM, or minimum of 72-hour battery backup shall be provided. The controllers shall be able to return to full
normal operation without user intervention after a power failure of unlimited duration. Operating programs shall be field-selectable for specific applications. Specific applications may be modified to meet the user’s exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of applications are not acceptable.

5. Unit conditioner controllers shall support the following types of terminal units as a minimum:

   Fan-coil units

   a. Fan-coil units may be of the following types:

      4-pipe heating or cooling.

6. Unit ventilator controllers shall support the following types of heating-only unit ventilator applications as a minimum:

   ASHRAE Cycle 1, 2 or 3
   ASHRAE Cycle 1, 2 or 3 with auxiliary reheat
   Nesbitt Cycle W
   Nesbitt Cycle W with auxiliary reheat

2.43 OPERATOR WORKSTATION SOFTWARE

A. Basic interface description:

1. Operator workstation interface software shall use English-language prompting, English-language point identification, and industry standard PC application software. The software shall provide, as a minimum, the following functions.

   a. Graphical viewing and control of environment.

   b. Scheduling and override of building operations.

   c. Collection and analysis of historical data.

   d. Definition and construction of dynamic color graphic displays.

   e. Editing, programming, storage, and downloading of controller databases.

2. Provide a graphical user interface which shall use a mouse or similar pointing device and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays with the pointing device.

   a. Provide that all operations can also be performed using the keyboard as a backup interface device.

   b. Provide at least 10 special function keys to perform often-used operations.

3. The software shall provide multi-tasking that allows the user to run several applications simultaneously. The mouse shall be used to quickly select and switch between multiple applications. This shall be accomplished through the use of Microsoft Windows® or similar industry standard software that supports concurrent viewing and controlling of systems operations.
4. Multiple-level password access protection shall be provided to allow the user manager to limit workstation control, display, and data base manipulation capabilities.

5. Software shall allow the operator to perform commands including, but not limited to, the following:
   a. Start up or shut down selected equipment
   b. Adjust setpoints
   c. Add/modify/delete time programming
   d. Enable/disable process execution
   e. Lock/unlock alarm reporting for points
   f. Enable/disable totalization for points
   g. Enable/disable trending for points
   h. Override PID loop setpoints
   i. Enter temporary override schedules
   j. Define holiday schedules
   k. Change time/date
   l. Automatic daylight savings time adjustments
   m. Enter/modify analog alarm limits
   n. Enter/modify analog warning limits
   o. View limits
   p. Enable/disable demand limiting for each meter
   q. Enable/disable duty cycle for each load

6. Reports shall be generated and directed to either CRT displays, printers, or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
   a. A general listing of all points in the network
   b. List of all points currently in alarm
   c. List of all points currently in override status
   d. List of all disabled points
   e. List of all points currently locked out
   f. DDC controller trend overflow warning
   g. List all weekly schedules
B. Scheduling:

1. Provide a graphical spreadsheet-type format for time-of-day scheduling and overrides of building operations. Provide the following spreadsheet graphic types as a minimum:
   a. Weekly schedules
   b. Zone schedules
   c. Monthly calendars

2. Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Each schedule shall include columns for each day of the week as well as holiday and special day columns for alternate scheduling on user-defined days. Equipment scheduling shall be accomplished by simply inserting occupied and unoccupied times into appropriate information blocks on the graphic. In addition, temporary overrides and associated times may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.

3. Provide zone schedule for each building zone. Each schedule shall include all commandable points residing within the zone. Each point may have a unique schedule of operation relative to the zone’s occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and rescheduling of points may be accomplished easily via the zone schedule graphic.

4. Monthly calendars for a 24-month period shall allow scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

C. Collection and analysis of historical data:

1. Trending capabilities shall allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting.

2. Trend data report graphics shall allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least 6 points. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package such as Lotus 1-2-3®. This shall allow the user to perform custom calculations such as energy use, equipment efficiency, and energy costs and shall allow for generation of these reports on high-quality plots, graphs, and charts.

D. Dynamic color graphic displays:

1. Color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air-handling units, chilled water systems and hot water boiler systems, shall be provided as indicated in the point I/O summary to optimize system performance analysis and speed alarm recognition.
2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.

3. Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.

4. The environment of the PC operator workstation shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

5. Graphic generation software shall allow the user to add, modify, or delete system graphic displays.

E. System configuration and definition:

1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:
   
a. Add/delete/modify DDC panel
   
b. Add/delete/modify operator workstations
   
c. Add/delete/modify application-specific controllers
   
d. Add/delete/modify points of any type and all associated point parameters and tuning constants
   
e. Add/delete/modify alarm reporting definition for points
   
f. Add/delete/modify control loops
   
g. Add/delete/modify energy management applications
   
h. Add/delete/modify time and calendar-based programming
   
i. Add/delete/modify totalization for points
   
j. Add/delete/modify historical data trending for points
   
k. Add/delete/modify custom control processes
   
l. Add/delete/modify any and all graphic displays, symbols and cross-reference to point data
   
m. Add/delete/modify dial-up telecommunication definition
   
n. Add/delete/modify all operator passwords
   
o. Add/delete/modify alarm messages

F. Additional workstation software:
1. Automatic dial-up communications shall include the following features as a minimum:

   a. **Dial-out:**
      
      (1) Manual dial-out from the workstation to remote networks shall be accomplishable using only a mouse to select and request the desired remote connection.

   b. **Dial-in:**
      
      (1) Alarms shall automatically dial into the workstation for display at the terminal and for hard-copy printout at the associated event printer.

      (2) Alarms shall, at the operator’s option, dial into a stand-alone modem-printer to provide for real-time alarm printouts even when the workstation is off-line (such as when it is being used to run operator-selected third party software).

      (3) Trend data shall be scheduled for automatic updating to the workstation at operator-selected times. The operator shall also have the option of manually collecting trend data at any time.

**PART 3 - EXECUTION**

**3.20 HARDWARE AND SOFTWARE INSTALLATION**

   A. Install the control system in accordance with manufacturer’s instructions, complete and operating as shown and specified.

   B. See drawings for the level of controller required for each type system control.

**3.61 TESTS**

   A. Installer shall test, calibrate, and adjust the system and perform final field test. Engineer shall witness test.

   B. **Final field test:**
      
      1. Sensors: Cross-check each sensor by comparing the reading at the sensor to a standard traceable to the National Institute of Standards and Technology (NIST).

      2. Control points: Cross-check each control point by comparing the control command to the field-controlled device.

      3. Verify that systems are operable from local controls in the specified failure mode upon panel failure or loss of power.

      4. Submit test results as required in “Submitals” in Part 1 above.

   C. **Compliance inspection:** Conduct the compliance inspection with the Owner’s designated representative and the Engineer. Conduct each activity described on the “Compliance Inspection Checklist” attached at the end of this Section. When each activity is satisfactorily completed, the Owner’s representative (user) and the Engineer (A/E) will initial and date the line provided on the checklist.

      1. If any item on the checklist cannot be complied with, submit a written explanation.

3.81 OPERATING INSTRUCTIONS

A. Coordinate instruction period with requirements of Section 15050.

B. Provide competent instructors to give full instruction to designated personnel in the adjustment, operation, and maintenance of the system installed, rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. Training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays as follows:

C. Provide two 8-hour days of training for Owner's operating personnel. Training shall include:

1. Explanation of drawings, operations, and maintenance manuals.
2. Walk-through of the job to locate control components.
3. Operator workstation and peripherals.
4. DDC panel and ASC operation/function.
5. Operator control functions including graphic generation and field panel programming.
6. Operation of portable operator's terminal.
7. Explanation of adjustment, calibration, and replacement procedures.

D. Provide 4 hours of additional training quarterly for a period of one year from final completion of the project.

E. The Owner may require personnel to have more comprehensive understanding of the hardware and software. Additional training shall be available from the installer, after completion of the work of the project. Provide description of available local and factory customer training.

END OF SECTION

Compliance Inspection Checklist follows Section.
COMPLIANCE INSPECTION CHECKLIST

Project: 

1. Manually generate an alarm at a remote DDC panel to demonstrate the capability of the workstation and alarm printer to receive alarms within 5 seconds.
   User_____________ Date____________ A/E____________ Date____________

2. Disconnect an operator workstation in the central control room and manually generate an alarm at a remote DDC panel to demonstrate the capability of the system printer to receive alarms when the workstation is disconnected from the system.
   User_____________ Date____________ A/E____________ Date____________

3. Disconnect one DDC panel from the network to demonstrate that a single device failure shall not disrupt or halt peer-to-peer communication. Panel to be disconnected shall be selected by the Engineer.
   User_____________ Date____________ A/E____________ Date____________

4. At a DDC panel of the Engineer's choice, display on the portable operator's terminal:
   a. At least one temperature setpoint and at least one status condition, (for example, on or off for a system or piece of equipment attached to that panel), as well as for points at another DDC panel on the network.
   b. The diagnostic results as specified for a system or piece of equipment attached to that panel as well as for a system or piece of equipment attached to another DDC panel.
   c. The ability to add a new point to the DDC panel with the POT and have it automatically uploaded to the workstation to modify that panel's stored database.
   User_____________ Date____________ A/E____________ Date____________

5. At an ASC of the Engineer's choice, disconnect the LAN connection to demonstrate its lack of reliance on a DDC panel to maintain full control functionality.
   User_____________ Date____________ A/E____________ Date____________

END OF CHECKLIST
SECTION 15950

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.11 SECTION INCLUDES

A. The Contractor shall engage and the Engineer shall approve an independent balancing and testing subcontractor.

B. This section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
   1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
   2. Adjusting total HVAC systems to provide indicated quantities.
   4. Setting quantitative performance of HVAC equipment.
   5. Verifying that automatic control devices are functioning properly.
   7. Reporting results of the activities and procedures specified in this section.

1.14 RELATED SECTIONS

A. Testing and adjusting requirements unique to particular systems and equipment are included in the sections that specify those systems and equipment.

B. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment sections.

1.27 PERFORMANCE REQUIREMENTS

A. Select and obtain approval of the testing and balancing subcontractor at the earliest possible time and before beginning ductwork installation.

B. The testing and balancing subcontractor shall visit the job site periodically, beginning with the initial stages of construction of the mechanical systems, and shall assure that the necessary devices are properly installed so that specified testing and balancing can be performed.

1.30 SUBMITTALS

A. General: Comply with Section 01330.

B. Submit qualifications of testing and balancing subcontractor, as required in article “Quality Assurance” below.

C. Submit certified balance report. In addition to general requirements for submittals, submit three copies of final reports and certificates, bound into a booklet.
1.40 QUALITY ASSURANCE

A. Testing and balancing subcontractor qualifications:
   1. Current certified member of the Associated Air Balance Council, or certified by National Environmental Balancing Bureau for air and hydronic systems testing and balancing.
   2. Has successfully completed at least five projects of similar size and scope.
   3. Not affiliated with any other subcontractor participating in this project. Work performed by the subcontractor shall be limited to testing, adjusting, and balancing HVAC systems.

B. Testing and balancing work shall comply with one of the following standards:

PART 2 - PRODUCTS

2.30 EQUIPMENT

A. Instruments: Approved and properly calibrated.
   1. Measure pump and coil pressure differentials with mercury manometers.
   2. Measure air temperature with mercury thermometers.
   3. Pyrometer surface temperature measurements may be used for piping system water temperatures where thermometer wells are not provided in the piping.

PART 3 - EXECUTION

3.02 VERIFICATION OF CONDITIONS

A. Before beginning balancing, ascertain that systems are ready. Verify that filters for regular service are in place, as required in Section 15861, Filters.

3.05 PREPARATION

A. Witness air duct leakage tests required in Section 15810, Ducts, and advise and approve the methods and instruments used.

B. Using bench-calibrated instruments, field-calibrate pressure gauges and dial-type duct thermometers.

3.21 BALANCING OF SYSTEMS, GENERAL

A. Tabulate settings of temperature control devices and ascertain that thermostats, controllers, and valves are set at specified or approved positions. Verify and certify that the sequence of operation for each system is as shown on drawings, specified, or approved.

B. Provide all labor and devices necessary for the testing and balancing work.
3.22 AIR SYSTEMS BALANCING

A. Balance all air distribution, supply, return, exhaust, and outside air systems and equipment.

B. Test and adjust fans to deliver design airflow at lowest possible speed. Adjust air-handling equipment to deliver the required air volumes. Note that air quantities scheduled on drawings do not include allowances for duct leakage. Preliminary adjustments of fan speed should be slightly in excess of scheduled airflow delivery. Make adjustments by adjusting adjustable sheaves, changing sheaves and associated belts, changing wiring connections of motors, or adjusting speed controller.

C. Test and adjust system to design airflow requirements.

D. Make pitot tube traverse of main supply, return, and outside air ducts to obtain total airflow for fan or air-handling unit.

E. Adjust rooms or zones to design airflow (supply, return, and exhaust).

F. Adjust general HVAC systems to design airflow within the following tolerances:
   1. Total system supply, return, and exhaust: (0 percent to plus 10 percent).
   2. Outside air: (minus 5 percent to plus 5 percent).
   3. Total supply, return, and exhaust for a room or space: (minus 5 percent to plus 5 percent).
   4. Grilles, registers, and diffusers:
      a. One per room or space: (minus 5 percent to plus 5 percent).
      b. Two or more per room or space: (minus 10 percent to plus 10 percent).

G. Grilles, registers, and diffusers:
   1. Identify each grille, register, and diffuser as to location and area. List manufacturer, type, and size.
   2. Identify type of testing equipment used.
   3. Test and adjust each grille, register, and diffuser to design airflow. List (design-actual) cfm (cubic meters per minute) and (design-actual) velocity in fpm (meters per second) when applicable.
   4. Adjust diffusers, grilles, and registers to minimize drafts. Adjust blades in supply diffuser straightening grids to assure uniform air distribution across diffuser.
   5. Adjust linear slot diffusers to provide throw direction as indicated on the drawings. Unless otherwise noted, discharge pattern shall be horizontal. Where two-way throw is indicated, divide the number of slots equally for each direction.

H. Test and record the following data, as applicable, for air-handling equipment:
   1. Manufacturer and model number.
   2. Total airflow (design-actual).
3. Return air airflow (design-actual).
4. Outside air airflow (design-actual).
5. Total and external static pressure (design-actual). Include static pressure at suction, discharge, and between unit coil and filter components.
6. Entering air temperatures (db heating, db and wb cooling).
7. Leaving air temperatures (db heating, db and wb cooling).
10. Fan speed, rpm (rated-actual).
11. Amperage (rated-actual).

In cooperation with the control manufacturer's representative, set adjustments of automatically operated dampers to operate as specified.

3.24 HYDRONIC SYSTEMS BALANCING

A. Balance all hydronic piping systems.

B. Adjust and balance the following items listed under the various systems in accordance with the specified standards.

1. Domestic hot water system:
   Pump
   Return piping for flow to every branch

2. Chilled water system:
   Pump
   Chilled water coils

3. Heating system:
   Pump
   Unit heater
   Heating water coils
   Air-handling unit
   Cabinet unit heater

C. After the above items have been adjusted and balanced, submit a certified report listing the specification requirements and the operating conditions of these items as follows:

1. Pump:
   Flow - gpm
   Suction pressure
   Discharge pressure
   Pressure differential
Total dynamic head
Motor - HP voltage, hertz, phase, design full load amps
Motor - operating line voltage and amperage, overload heater ratings.

2. Chilled water coils (such as coils in air-handling units and fan-coil units):

   Flow - gpm
   Entering air - D.B.
   Entering air - W.B.
   Leaving air - D.B.
   Leaving air - W.B.
   Entering water temperature
   Leaving water temperature
   Pressure drop across coil
   Outside air temperature - D.B.
   Outside air temperature - W.B.

3. Heating water coil (such as coils in air-handling units, unit heaters, and fan-coil units):

   Flow - gpm
   Entering water temperature
   Leaving water temperature
   Entering air - D.B.
   Leaving air - D.B.

4. Piping system:

   Flow - gpm reading of flow meter in various systems: See drawings for locations.

5. Heat exchanger:

   Flow - gpm
   Entering water temperature
   Leaving water temperature
   Pressure drop across heat exchanger

3.26 MARKING OF SETTINGS

A. Following final balance procedures, permanently mark the settings of valves, splitters, dampers, and other adjustment devices, so that adjustment can be restored if disturbed at any time. Set memory stops on balancing valves. Return and make required adjustments after submittal and approval of the Certified Balance Report.

END OF SECTION

END OF SPECIFICATIONS