PERFORMANCE SPECIFICATIONS

STUDENT HOUSING, PHASE 2

SOUTHERN UTAH UNIVERSITY
LEARNING LIVES FOREVER

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DFCM # 07032730

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Part 1 GENERAL

1 Commissioning Authority

A. The commissioning authority (CA) Heery International Inc. has been contracted directly with the owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. However commissioning involves all parties involved with the design and construction process, including the owner, architect and engineer, general and sub-contractors.

2 Contractor Responsibility

A. This Section of the specifications defines the contractor‘s responsibilities with respect to the commissioning process. Each contractor and sub-contractor, and or vendors will review this Section, and shall include in their bids for carrying out the work described, as it applies to each Division and Section of these specifications, individually and collectively.

3 Description of Work

A. The purpose of the commissioning process is to provide the owner/operator of the facility with independent verification that the mechanical systems have been installed according to the contract documents, and operate within the performance guidelines set out in the design intent documents (D\D) and these specifications. The CA shall provide the owner with an unbiased, objective view of the system‘s installation, operation, and performance. The commissioning process does not alleviate or reduce the responsibility of the installing contractors to provide a finished product, installed and fully functional in accordance manufactures recommendations within the design specifications and contract documents.

B. Commissioning is intended to enhance the quality of system start-up and aid in the orderly completion and transfer of systems for beneficial use by the owner. The CA will be the leader of the commissioning team, planning and coordinating all commissioning activities in conjunction with the design professionals, project manager, general contractor, subcontractors, vendors, manufacturers and equipment suppliers.

C. The General Contractor; Mechanical Contractor, and all Division 15 sub-contractors; Electrical Contractor, and all Division 16 sub-contractors shall be responsible for cooperating, and coordinating their work, with the CA. They shall also be responsible for carrying out all the physical activities required for installation of components and systems, testing and operating them during the commissioning process as required in this Section.

4 Related Documents

A. Drawings and general provisions of the contract, including general and supplementary conditions, general mechanical and electrical provisions and applicable Divisions 15 and 16 Specification sections, apply to work of this section. (See Sections 01800 Commissioning Of HVAC).

Part 2 PRODUCTS

1 Systems to be Commissioned

A. Systems installed under this contract are to be inspected, tested using calibrated meters and instruments, operationally signed off as complete, and demonstrated for the commissioning authority as compliance with the independent verification requirements as described in Part 3 of this Section. This includes, but is not necessarily limited to the work listed for each system. The foregoing includes all the following:

1. Hot and cold water piping systems–work includes installation inspections and checks; pressure tests and documentation; expansion tanks; confirmation of flow balancing completion; seismic restraints installation certification.

2. Refrigeration Compressor/Condensing Unit(s)–Work includes installation inspection and checks (including seismic restraints installation certification); checkout and startup by manufacturer‘s representative as specified; documented performance measurements including capacity, evaporator and condenser pressures, motor current draw, and controls operation.

3. Boiler(s)–Work includes installation inspections and checks (including seismic restraints installation certification); boil out and chemical treatment; checkout and startup by manufacturer‘s representative; documented performance measurements including combustion efficiency, capacity test, burner and controls operation. Perform hydrostatic testing using the approved methods and methodology of the applicable standards such as; **Division 15 documents will supersede the items listed below as applicable;**
   1. ASME
   2. ISA
   3. ASHRAE
   4. ANSI
4. Pumps–Work includes documented checks on alignment, rotation, motor current draw, flows and pressures.

   A. Terminal Units, Unit Ventilators, Variable Air Volume, Fan Powered Boxes, and all air-distribution systems–work includes installation inspections and checks; confirmation of flow balancing completion; room pressure interaction; leak testing as applicable; seismic restraints installation certification.

5. Exhaust Fans and Fume Extraction Systems–Work includes checks on installation (including seismic restraints, dampers and other accessories), rotation, sound levels, motor current draw, and airflows and pressures.

6. Air Handling Units; AHU, MUA, RAH, (packaged units)–Work includes installation inspections and checks (including seismic restraints installation certification); checkout and startup by manufacturer‘s representative as specified; documented capacity tests, for heating, cooling, air flow and static pressures; operation of all controls; sound level.
7. Direct digital controls (DDC) system, Lighting Control systems, and Fire Alarm systems–Work includes inspections and checks of installation, calibration and operation of all devices; complete operation of all controls sequences, verification of alarms and graphics in coordination with commissioning of all controlled systems.

8. Emergency Power Backup systems-Work includes installation inspections and checks; checkout and startup by manufacturer‘s representative as specified; documented load bank capacity tests.

9. Electrical power new installations, modifications, additions, retrofitted equipment, or upgraded equipment, such as;
   1. Main Switch Gear
   2. Switch-boards
   3. Main Fused Switches
   4. Substations
   5. Transfer Switches
   6. Breakers
   7. Panel-boards
   8. UPS \ Batteries systems
10. The following acceptance criteria will be used in the inspection and performance testing of the above listed items but not limited to. Division 16 documents will supersede the items listed below as applicable;
    1. NEC \ NECA applicable up to date code book
    2. IEEE applicable codes and performance criteria
    3. NETA applicable codes and performance criteria.

The contractor shall be responsible for carrying out all work required for commissioning these systems that is defined as a contractor responsibility in Part 3 of this Section.

2 Commissioning Pre-Functional Acceptance Tests

A. This specification contains the Commissioning Pre-Functional Acceptance Tests as listed below (See Appendix A):

Sheet #	**Air Systems**
A 01*	Air System Commissioning Progress Status Sheet (* by CA)
A 02	Ductwork Air Leakage Test Sheet
A 03	Air System Installation Completion Check Sheet
A 04	Air System Pre - TAB Check Sheet
A 11	Air Filter Check Sheet
A 12	Fire Damper Check Sheet
A 13	Motor Driven Fire/Smoke Damper Check Sheet
Sheet #	**Electrical Systems**
E 08	Motor Pre-Start Electrical Check Sheet
Sheet #	**General**
G 01	Comment Sheet
G 02	Sketch Sheet
G 03	Notification to Observe Test
G 04	Non-Compliance Certificate
G 05	Witness Certificate
G 06	Acceptance Certificate
Sheet #	**Plumbing**
P 01*	Plumbing System Commissioning Progress Status Sheet (* by CA)
P 02	Pipe work Hydraulic Pressure Test Sheet
P 03	Plumbing System Installation Completion Check Sheet
P 04	Plumbing System Pre-Pump Test Check Sheet
P 05	Domestic Water Pump Test Sheet

Sheet #	**Water Systems**
W 01*	Water System Commissioning Progress Status Sheet (* by CA)
W 02	Pipe work Hydraulic Pressure Test Sheet
W 03	Water System Installation Completion Check Sheet
W 04	Water System Pre - TAB Check Sheet
W 06	Flushing Record Sheet
W 09	Inhibitor / Glycol Level Test Sheet

2.1 Functional Acceptance Test Checklists

A. Functional Acceptance Test Checklists for the equipment listed below will be provided by the commissioning authority to the project manager for distribution one month prior to the scheduled start of Functional Acceptance Testing.

1	AHU's, MUA, RAH	Classrooms and Offices Balancing 10% of Diffusers
2	Exhaust fans	Restrooms, Dark Room, Chemical Storage, Lab Hoods, & Ex.
3	Terminal Units, VAV's, FPB's, & Cabinet Unit Heaters; all air type devices	.Coils, fan blower, fan motor, and controls
4	Heat Pump Units, Dx Units, Split Systems	Refrigeration Units, Valves, Coils, Evaporators, Condensers, fan motors, and controls
5		
6	Chillers	Condenser, Evaporators, pumps, controls, tanks, cooling towers, chemical injection systems, and ancillary equipment associated to include balancing valves.
7	Boilers	Heating Water System, pumps, controls, tanks, glycol system, chemical injection systems, and ancillary equipment associated to include balancing valves.
8	Lighting Control System	Control S.O.O. , relays, fixtures, emergency lighting
9	Security Alarm System	Monitoring Devices, Alarms, and Sensors
10	Fire Alarm System	Monitoring Devices, Alarms, Horns, Flow Switches, and Sensors
11	Building Automated System	Control, Points, Graphics, Alarms, Trending, and Monitoring Devices

2.2 Members of the Commissioning Team

A. The commissioning team will consist of representatives of the following:

1	Owner (O)	DFCM Utah State
2	Project Manager (PM)	DFCM Utah State
3	Architect (A)	HFC
4	Mechanical Design Engineer (ME)	TBD
5	Electrical Design Engineer (EE)	TBD
6	Commissioning Authority (CA)	Heery International, Inc.
7	General Contractor (GC)	TBD

8	Mechanical (Div. 23) Contractor (M)	TBD
9	Electrical (Div. 26) Contractor (E)	TBD
10	Controls Contractor (CC)	TBD
11	Sheet Metal Contractor (SM)	TBD
12	Testing, Adjusting, and Balancing Agency	TBD
13	Fire Alarm Contractor (FA)	TBD
14	Owner's O&M Staff (OM)	TBD

A. During the commissioning process, participation of team members will generally be required as noted in the following table (with abbreviations as noted in brackets in the preceding list of team members). The mechanical contractor, indicated by —M", includes all mechanical sub-contractors or suppliers whose participation is required for commissioning a particular system or piece of equipment.

Process	**O**	**PM**	**A**	**ME**	**EE**		**CA**	**GC**	**M**	**E**	**CC**	**SM**	**TAB**	**SSC**	**OM**
Commissioning Kick-Off Meeting / Distribution of Commissioning Plan prepared by CA	X	X	X	X	X		X	X	X	X	X	X	X	X	
Pre-Functional AcceptanceTesting Meeting		X		X	X		X	X	X	X	X	X		X	
Pre-Functional Acceptance Tests Testing by Installing Contractors / Witness by CA							X	X	X	X	X	X	X	X	
Functional Acceptance Testing Documentation Prepared by CA / Submitted		X					X				X			X	
Process	**O**	**PM**	**A**	**ME**	**EE**		**CA**	**GC**	**M**	**E**	**CC**	**SM**	**TAB**	**SSC**	**OM**
Pre-TAB Meeting		X					X	X	X		X	X	X		
TAB by TAB Contractor							X				X		X		
Functional Acceptance Testing Meeting		X			X		X	X	X	X	X		X	X	X

Functional Acceptance Testing by Contractors per Documentation, Witness by CA							X	X	X	X	X			X	
Preparation of Final Commissioning Report by CA		X	X	X			X								
Owner O & M Staff Training by Contractors, Witness by CA							X	X	X	X	X			X	X

Part 3 **EXECUTION**

1 Commissioning Responsibilities

A. Introduction

1. As noted in 2.4, a multidisciplinary team carries out commissioning. The commissioning responsibilities of team members during the construction and acceptance phases of the project are provided here for information, and shall provide some context for the overall process.

2 Commissioning Authority Responsibilities

A. The Commissioning Authority will:

a) Plan, organize and implement the commissioning process as specified herein;

b) Prepare the commissioning plan, and ensure its distribution for review and comment;

c) Revise the commissioning plan as required during construction;

d) Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting;

e) In conjunction with the Project Manager, coordinate commissioning activities among all contractors, sub-trades and suppliers;

f) Monitor Pre-Functional Acceptance Tests checks, and validate the results are documented as the checks are done;

g) Monitor controls point-to-point checks done by the controls contractor, and ensure the results are documented as the checks are done;

h) Observe start-ups and initial system operations tests and checks;

i) Direct the contractors to operate equipment and systems as required to validate that all required functional performance tests are carried out for verification purposes;

j) Witness all functional performance tests and document the results;

k) prepare and submit a Commissioning Report which documents all checks and tests done throughout the Commissioning process, and the results obtained from each; and

l) ensure all required O&M manuals, instructions and training are provided to the Owner‘s designated operating staff.

B. Architect / Engineers Responsibilities

1. The Architect / Engineers will review the Commissioning Plan, and will participate, as appropriate, in on-site commissioning meetings.

2. During the acceptance phase of the commissioning process, the Architect / Engineers may be on site to review commissioning documentation, to witness functional performance tests, and to analyze the installation and its performance. HVAC systems performance acceptance will rest with the Architect.

C. Owner‘s Responsibilities

1. The Owner will ensure the availability of operating staff for all scheduled instruction, demonstration and training sessions. This staff will possess sufficient skills and knowledge to operate and maintain the installation following attendance at these sessions.

2. The Owner will also ensure the appropriate involvement of the MEP Engineers, Architect, and any other consultants as required, in the commissioning process.

D. Commissioning Responsibilities–General Contractor

1. The General Contractor has responsibility to ensure the overall completion of the Work. In this regard, he shall:

a) Participate as required in the HVAC commissioning process,

b) Ensure the Mechanical Contractor performs all assigned HVAC commissioning responsibilities as specified in 3.6,

c) Ensure the Electrical Contractor performs all assigned HVAC commissioning responsibilities as specified in 3.7,

d) Ensure the cooperation and participation in the HVAC commissioning process of all other sub-contractors as applicable.

2. The General Contractor shall assign a representative to the commissioning team, and submit the person‘s name to the commissioning authority, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the general contractor as they relate to the organization and scheduling of HVAC commissioning. The representative

shall facilitate communications among all contractors and suppliers and other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to precede on schedule.

3. In the event that any scheduled equipment or system start-ups or functional performance tests are terminated because the CA or the mechanical engineer discover deficient or incomplete work, or due to the non-attendance of required contractor or supplier personnel, the contractor or sub-contractor responsible for the termination may also be responsible for paying reasonable costs of time and travel expenses of any or all of the following representatives who were physically present for the purpose of witnessing the start-up or the FPT: the CA, the mechanical engineer, the electrical engineer, and the owner [or project manager]. The owner [or project manager] may provide a statement to the General Contractor identifying the specific activity that was terminated, the scheduled date, and a list of those in attendance, along with their reasonable time and travel expense costs.

E. Commissioning Responsibilities–Division 15(Mechanical) Contractor

1. The mechanical contractor, and all the sub-contractors and suppliers within Division 15, shall cooperate with the commissioning authority (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.

2. The contractor shall assign a representative to the commissioning team, and submit the person‘s name to the commissioning authority, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the mechanical contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall ensure communications between Division 15contractors and suppliers and all other commissioning team members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to precede on schedule.

3. The mechanical contractor, and all mechanical sub-contractors and suppliers, shall cooperate with the commissioning authority in carrying out the HVAC commissioning process. In this context, the mechanical contractor shall:

    a) Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.

    b) Ensure the testing and balancing contractor (TAB) performs HVAC commissioning responsibilities as listed in 3.8.

    c) Ensure the building management systems controls contractor (CC) performs HVAC commissioning responsibilities as listed in 3.9.

    d) Provide instruction and demonstrations for the Owner‘s designated operating staff, in conjunction with the commissioning authority and mechanical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.

    e) Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.

f) Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, and water treatment as applicable.

g) Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.

h) Attend HVAC commissioning meetings scheduled by the CA.

i) Notify the CA a minimum of seven (7) days in advance of scheduled equipment and system start-ups, so that the CA may witness Pre-Functional Acceptance Tests checks, and equipment and system start-ups.

j) Provide sufficient personnel to assist the CA as required during Pre-Functional Acceptance Tests checks and Functional Acceptance Testing.

k) Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which Pre-Functional Acceptance Tests are included in the commissioning specification, Appendix A. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe start-up.

l) Notify the CA a minimum of seven (7) days in advance, of the time for start of the TAB work. Attend the initial TAB meeting for review of the TAB procedures.

m) Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken.

n) Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.5 © in this Section. Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the CA to witness formal functional performance tests (FPTs).

o) Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning authority. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.5 © in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the control contractor (CC) and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.

p) Prepare preliminary schedule for mechanical system orientation and inspections. O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.

q) Attend initial O&M staff training session.

r) Conduct mechanical system orientation and inspection at the equipment placement completion stage.

s) Update drawings to as-built condition and review with the CA.

t) Gather O&M data on all equipment, and assemble in binders as required by the contract specification. Submit to CA prior to the completion of construction.

u) Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the CA.

v) Provide written notification to the general contractor, project manager and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.

1. HVAC equipment including all fans, air handling units, ductwork, dampers, and all Division 15 equipment.

2. Refrigeration equipment, pumping systems and heat rejection/transfer equipment.

3. Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.

4. Seismic restraints installed to specification; a certification from the seismic restraint engineer meets this requirement.

5. Non-dedicated systems using the air-handling units for smoke control.

6. Fire detection and smoke detection devices furnished under other divisions of this specification as they affect the operation of the smoke control systems.

7. That the building control system is functioning to control mechanical equipment and smoke control systems as specified.

8. Provide a complete set of as-built drawings and O&M manuals to the CA.

F. Commissioning Responsibilities–Division 16 (Electrical) Contractor

A. The electrical contractor, and all the sub-contractors and suppliers within Division 16, shall cooperate with the commissioning authority (CA), and other commissioning team members, to facilitate the successful completion of the commissioning process.

B. The contractor shall assign a representative to the commissioning team, and submit the person‘s name to the commissioning authority, within one (1) month of the award of the contract. The representative shall have the authority to make decisions on behalf of the electrical contractor as they relate to the organization and scheduling of HVAC commissioning. The representative shall ensure communications between Division 15contractors and suppliers and all other commissioning team

members, and shall foster the necessary cooperative action. One specific responsibility shall be to attend commissioning meetings, and ensure action items arising from them are attended to as required to allow the commissioning process to precede on schedule.

C. The electrical contractor, and all electrical sub-contractors and suppliers, shall cooperate with the commissioning authority in carrying out the HVAC commissioning process. In this context, the electrical contractor shall:

a) Each contractor and sub-contractor in this division shall include in their quotes the cost of participating in the commissioning process as specified herein.

b) Ensure the Fire Alarm contractor performs HVAC commissioning responsibilities as listed in 3.10.

c) Ensure the building management systems controls contractor (CC) performs HVAC commissioning responsibilities as listed in 3.9.

d) Provide instruction and demonstrations for the Owner‘s designated operating staff, in conjunction with the commissioning authority and electrical engineer, and with the participation of qualified technicians from major equipment suppliers and the controls contractor.

e) Include requirements for submittal data, O&M data, and training information in each purchase order or sub-contract written.

f) Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, and water treatment as applicable.

g) Ensure participation of major equipment manufacturing in appropriate start-up, testing and training activities.

h) Attend HVAC commissioning meetings scheduled by the CA.

i) Notify the CA a minimum of seven (7) days in advance of scheduled equipment and system start-ups, so that the CA may witness Pre-Functional Acceptance Tests checks, and equipment and system start-ups.

j) Provide sufficient personnel to assist the CA as required during Pre-Functional Acceptance Tests checks and Functional Acceptance Testing.

k) Prior to start-up, inspect, check and confirm the correct and complete installation of all equipment and systems for which Pre-Functional Acceptance Tests are included in the commissioning specification, Appendix A. Document the results of all inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe start-up.

l) Notify the CA a minimum of seven (7) days in advance, of the time for start of the Fire Alarm work. Attend the initial Fire Alarm meeting for review of the Fire Alarm procedures.

m) Provide equipment and systems start-up resources as specified and required. If during an attempted equipment or system start-up, deficient or incomplete work is discovered that would preclude safe operation, the start-up shall be aborted until corrective action has been taken.

n) Ensure such action is taken and verified before re-scheduling a new start-up. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.5 © in this Section. Carry out performance checks to ensure that all equipment and systems are fully functional and ready for the CA to witness formal functional performance tests (FPTs).

o) Operate equipment and systems for FPTs in accordance with the commissioning plan and as directed by the commissioning authority. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work will be responsible for costs in accordance with 3.5 © in this Section. Ensure that all corrections necessary for full and complete system operation as specified are completed; then with the control contractor (CC) and other applicable sub-contractors, carry out functional performance checks to confirm correct operation before applying to the CA to reschedule the FPTs for the system in question.

p) Prepare preliminary schedule for electrical system orientation and inspections. O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, TAB, and task completion for use by the CA. Update schedule as appropriate throughout the construction period.

q) Attend initial O&M staff training session.

r) Conduct electrical system orientation and inspection at the equipment placement completion stage.

s) Update drawings to as-built condition and review with the CA.

t) Gather O&M data on all equipment, and assemble in binders as required by the contract specification. Submit to CA prior to the completion of construction.

u) Participate in, and schedule vendors and contractors to participate in the O&M staff training sessions as set up by the CA.

v) Provide written notification to the general contractor, project manager and CA that the following work has been completed in accordance with the contract documents and the equipment, systems and sub-systems are operating as required.

    1. Electrical equipment including all switches-boards, main switches, substations, breakers, panel-boards and all Division 16 equipment.

    2. Generators, ATS’s, UPS’s, Battery Racks, and all electrical transfer equipment.

    3. Fire stopping in the fire rated construction, including fire and smoke damper

installation, caulking, gasketing and sealing of smoke barriers.

4. Seismic restraints installed to specification; a certification from the seismic restraint engineer meets this requirement.

5. Non-dedicated systems using the air-handling units for smoke control.

6. Fire detection and smoke detection devices furnished under other divisions of this specification as they affect the operation of the smoke control systems.

7. That the building control system is functioning to control electrical equipment and smoke control systems as specified.

8. Provide a complete set of as-built drawings and O&M manuals to the CA.

D. Commissioning Responsibilities–TABB | NEBB Certified Agency

1. With respect to HVAC commissioning, the TAB agency shall:

   A. Include costs for HVAC commissioning requirements in the quoted price.

   B. Attend commissioning meetings scheduled by the CA prior to, and during, on-site TAB work being done.

   C. Submit proposed TAB procedures to the CA and mechanical engineer for review and acceptance.

   D. Attend the TAB planning meeting scheduled by the CA. Be prepared to discuss the method and procedures that shall be followed in testing, adjusting and balancing the HVAC with general contractor, CA, and mechanical engineer notified.

   E. Participate in verification of the TAB report by the CA for verification or diagnostic purposes. This will consist of repeating a sample (normally 10% to 20%) of the measurements contained in the TAB report as directed by the CA.

   F. Participate in O&M personnel training sessions as scheduled by the CA.

E. Commissioning Responsibilities–Controls Contractor

1. With respect to HVAC commissioning, the controls contractor shall:

   A. Include cost for commissioning requirements in the quoted price.

   B. Review design for controllability with respect to equipment selected for the project;

   C. Review and confirm in writing that a proper hardware specification exists to permit Functional Acceptance Testing as required by specification and sequence of operation.

   D. Review and confirm in writing that proper safeties and interlocks are included in design.

   E. Ensure the proper sizing of control valves and actuators, based on design flow rate and

pressure drops. Ensure that control valve authority will result in capacity control as specified. Include valve sizing and authority information in submittal to mechanical engineer.

F. Ensure the proper sizing of control dampers. Ensure damper authority to control air flows as specified. Review and confirm in writing proper damper positioning for mixing to prevent stratification. Ensure correct actuator vs. damper movement for smooth operation. Include damper sizing, control authority and actuator selection data in submittal to mechanical engineer.

G. Ensure the proper selection of sensor ranges, and include data with submittal to mechanical engineer.

H. Clarify all questions concerning sequences of operation with the mechanical engineer and CA.

2. Attend commissioning meetings scheduled by the CA.

3. Provide the following submittals to the CA for review;

A. Hardware and software submittals.

B. Control panel construction shop drawings.

C. Diagrams showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access, all superimposed on diagrams of the physical equipment.

D. Narrative description of all control sequences for each piece of equipment controlled.

E. Logic diagrams showing the logic flow of all control sequences.

F. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.

G. A complete control language program listing including all software routines employed in operating the control system. Also provide a program write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the software and the functions of each routine and sub-routine. It should also explain individual math or logic operations that are not clear from reading the software listing.

H. Hardware operation and maintenance manuals.

I. Application software and project applications code manuals.

4. Conduct over the shoulder training to the Graphic displays and physical plant anatomy

A. Inspect, check, and confirm the proper installation and performance of controls/BAS hardware and software provided by others.

B. Integrate installation and programming scheduling with construction and commissioning schedules.

C. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts.

D. Provide thorough training to operating personnel on hardware operations and programming, and the application program for the system, in accordance with the O&M staff training program in the commissioning plan.

E. In conjunction with the mechanical contractor, demonstrate system performance to the CA including all modes of system operation (e.g. occupied, unoccupied, and emergency) during the functional performance tests (FPTs). If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the FPTs will be stopped by the CA. Those responsible for deficient or incomplete work may be responsible for costs in accordance with 3.2 in this Section.

F. Provide control system technician to assist during approved support and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to the TAB contractor and commissioning authority, all devices, such as portable operator‘s terminals and all software for the TAB contractor to use in completing TAB procedures.

F. Special Systems Subcontractor (Fire Alarm, CCTV, Security, Intercom, etc.):

1. Provide Commissioning Agent and General/Electrical Contractor with controls system and wiring diagrams, narrative sequences of operation, and software documentation printout of actual programmed sequences prior to loading into field controllers and in time for use in point to point testing.

2. Review the Commissioning Plan, Cx milestone schedule and assist in preparing the Functional Test Procedures. Provide input required to develop final plans and procedures that all commissioning team members accept as a fair means of verifying compliance with commissioning goals and the project contract.

3. Participate in any required efforts to finalize sequences of operations with Owner, Designers and Commissioning Agent.

4. Coordinate installation of controls system with equipment suppliers, General and electrical Subcontractors. Verify that coordination, installation, quality control, and final Subcontractor testing have been completed such that installed systems and equipment comply with construction documents.

5. Notify the Owner, Commissioning Agent, Designers and Contractor as soon as possible of any system installation issues identified during construction that may compromise system control capability.

6. Participate in start-up and Operational and Functional testing as required. This will require dedicated, full time support of the Operational and Functional Acceptance Testing efforts during commissioning.

7. Complete Installation and Pre-Commissioning Test Checklists and other supporting documentation as required demonstrating completion of control system installation, point-to-point verification (including device calibration), start-up and testing, and submitting to the

Commissioning Agent.

8. Participate in fine-tuning or troubleshooting of system performance if either of these measures becomes necessary.

9. Provide the Owner and Commissioning Agent with final documentation for all installed conditions, including as-built drawings and detailed narrative sequences of operation as determined during commissioning process.

END OF SECTION

Project System …….. Date ……..	**Sheet No** **G 03**

Notification to Observe Test

To .....

Could you please arrange to inspect/witness the following test:

Nature of test .....

Date of test ..... Duration of test .....

Test sheets attached .....

.....

Signed ..... for and on behalf of ..... Trade Contractor

Notice required: Off Site - 7 days On Site Testing - 3 days On Site Inspection - 1 day

Observed by:

..... Signed..... Accepted/Not accepted

..... Signed..... Accepted/Not accepted

..... Signed..... Accepted/Not accepted

Remarks

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Project …… System …….. Date ……..	**Sheet No** **G 04**

Non-Compliance Certificate No. .....

System .....

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Plant Location .....

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Test sheets attached.....

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Witnessing Authority .....

The above system and test data have been witnessed and require further investigation as noted below:

Comments .....

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Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

Heery International Inc

Project System …….. Date ……..	**Sheet No** **G 05**

Witness Certificate No. …..

System .....

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Plant Location .....

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Test sheets attached.....

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Witnessing Authority .....

The above system and test data have been witnessed as a factual representation of plant performance.

Comments.....

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Heery International Inc

Project …… System …….. Date ……..	**Sheet No** **G 06**

Acceptance Certificate No. …..

System .....

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Plant Location .....

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Test sheets attached.....

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Witnessing Authority .....

The above system and test data have been witnessed as a factual representation of plant performance and are accepted as to be within the performance criteria and tolerances.

Comments .....

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Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

Project …… System …….. Date ……..	**Sheet No** **G 11**

Inspection Record Sheet

Ref	Date	System Inspected	Location

Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

Heery International Inc

Project ...	Sheet No
System .....….....Date….....	A 01

Air Systems Commissioning Progress Status Sheet

The following are the necessary checks and tests to fully commission each air system.

Test Required	Sheet No	Signed and Witnessed
Ductwork Pressure Test	A 02	
Installation Complete	A 03	
Fire Damper & MFSD Checks Complete	A 12/A 13	
Fan Pre-Commissioning	A 04	
Motor Pre Start Electrical Checks	E 08	
Fan Test Sheet (initial & final)	A 05	
Air System Proportional Balance	A 06	
Air System Branch Volume Summary	A 07	
VAV Box Checks (where required)	A 08	
Fan Coil Unit Checks (where required)	A 09	
Air Handling Unit Inspection Check	A 10	
Air Filter Inspection Check	A 11	
System Cx Schematic Sketch Sheet	G 02	
Safety Stops and Frost Stat Operation	Hand / Auto	
Damper StrokingOperation	BMS	
Valve Stroking Operation	BMS	
Dirty Filter Switches ΔP Operation	BMS	
Air Flow ΔP Switches Operation	BMS	
Temperature Control Loops	BMS	
Humidity Control Loops	BMS	
Fan Tracking Control Loop	BMS	
Minimum Fresh Air / CO^2 Control Loops	BMS	
Optimum Start / Night set-back Control Loops	BMS	

System ready for Integrated Funtional Test Procedure……..Date……..Signed……..……..

Project ... **System** .....**Date**….....	**Sheet No** **A 02**

Ductwork Air Leakage Contractors Test No .....

Part 1 - Physical Details

(a) Section of ductwork to be tested.....

(b) Surface area of duct under test* .....ft²

(c) Test leakage static pressure .....in wc

(d) Leakage factor .....

(e) Maximum permitted leakage (b x d) .....cfm

* Calculation for surface area of ductwork under test to be appended.

Part 2 - Test Details

(a) Duct static pressure reading .....in wc

(b) Type of flow measuring device .....small / medium / large nozzle

(c) Range of measurement on flow measuring device .....cfm

(d) Reading of flow measuring device .....in wc

(e) Interpreted air flow leakage rate .....cfm

(f) Duration of test (normally 15 minutes) .....mins

Part 3 - Calibration Details

(a) Type of test instrument .....

(b) Serial No .....

(c) Calibration Certificate No .....

(d) Date Issued .....

Comments

Tested by: ..... **Engineer** **for and on behalf of**	**Witnessed by:** ..... **Engineer** **for and on behalf of** .....

Project System …….. Date ……..	**Sheet No** **A 03**

(Air System) Installation Completion Check Sheet

1.	Ductwork installation complete and tested A-02 checks complete……	[ ]
2.	All test blanks-offs removed.	[ ]
3.	Air handling units / fans installed correctly and clean.	[ ]
4.	All terminal grills / diffusers installed.	[ ]
5.	All grill / diffuser dampers operate and left fully open.	[ ]
6.	All duct balancing dampers operate and left fully open.....	[ ]
7.	All fire dampers operate and left fully open. **A-11** and/or **A-12** checks complete.....	[ ]
8.	All access doors on Air Handling Unit and ductwork installed and secure.	[ ]
9.	All flexible connections installed and checked for integrity.	[ ]
10.	Ductwork internally clean and free from obstructions.	[ ]
11.	Fresh air intake and exhaust louvers free from obstructions.	[ ]
12.	Air shafts, plenum, ducts clean and air tight.....	[ ]
13.	Coil air ways clean and unobstructed.....	[ ]
14.	Condensate drains fitted, trapped and flow freely.	[ ]
15.	Clean air filter elements fitted (except HEPAs). **A-11** checks complete	[ ]
16.	Drives correct, secure and guards fitted properly.	[ ]
17.	Equipment transit packing material, shipping blocks, etc. removed.	[ ]
18.	Anti-vibration mountings properly installed and adjusted.....	[ ]
19.	Access provided in false ceiling/floor voids etc. at each adjustable item.....	[ ]

Comments

Authorization: …….. Installation complete and ready for startup.

Date. ..... **Signed**.....….....**Position**.....

For and on behalf of .....**Installing Contractor**

Project System …….. Date ……..	**Sheet No** **A 04**

(Air System) Pre-TAB Check Sheet

1. Fan and motor mounting bolts secure. ……. [ ]
2. Fan chamber and internals clean and free from debris. ……. [ ]
3. Shipping packaging and shipping blocks removed……. [ ]
5. Correct drive installed ……. [ ]
6. Drive pulleys aligned and tight on shafts……. [ ]
7. Drive belts tensioned…….. [ ]
8. Guards correctly fitted ..... ……. [ ]
9. Fan free to rotate by hand ..... ……. [ ]
10. Filter media installed and clean *(approved temporary material may be used)* .... ……. [ ]
11. All duct and grill volume control dampers open ..... ……. [ ]
12. All fire dampers checked and left open ..... ……. [ ]
13. All access doors installed properly and securely ..... ……. [ ]
14. Intake louvers and plenum free from obstruction…….. [ ]
15. Cooling coil drains/traps complete……. [ ]
16. Motor pre-start electrical check sheet issued and signed. Sheet(s) **E 08**/Dated…..
17. Complete Ductwork System pressure tests received. Sheet(s) **A 02**/Dated……
18. Installation Completion Check Sheet issued and signed Sheet(s) **A 03**/Dated……...

Comments

Authorization: .... System ready for TAB regulation.

Date. ..... **Signed**.....….....**Position**.....

For and on behalf of ..... **TAB Subcontractor**

Project…	**Date**……..	**Sheet No A 09**
System…… ……	**Unit Ref** …….....	

Fan Coil Unit Check Sheet

Static Checks

1. Surrounding area clean and unit internally clean..... [ ]
2. Fixings/supports secure ..... [ ]
3. Fan free to rotate by hand..... [ ]
4. Inlet/discharge guards installed securely..... [ ]
5. Filter media installed and clean..... [ ]
6. Damper seals OK and motor installed and secure ..... [ ]
7. Sensor aspirator tubing sealed OK..... [ ]
8. Floor grill installed and sealed..... [ ]
9. Pipework completed and free from strain ..... [ ]
10. Control valve/actuator installed and wired ..... [ ]
11. Fan coil power and control sub-fusing OK..... [ ]
12. Wiring complete and tested (including grounding checks) ..... [ ]
13. Drainage pan and water trap seal..... [ ]

Dynamic Checks

1. Fan free from undue noise and vibration ..... [ ]
2. Damper operation OK ..... [ ]
3. Sensor aspiration operating OK..... [ ]
4. Motor temperature normal..... [ ]
5. Control valve operational ..... [ ]

Test Data

	Design	**Result**		**Design**	**Result**
Air Volume	cfm	cfm	Air Temp In/Out	°F	°F
			Water Temp In/Out	°F	°F

Tested by: ..... **Engineer** **for and on behalf of**	**Witnessed by:** ..... **Engineer** **for and on behalf of** .....

Project System Date ……..	**Sheet No** **A 10a**

Air Handling Unit Inspection Check Sheet

Unit Identification: **AHU-** Type: SER: [ ]

Pre Installation Inspection. Specification Details

1. Does the unit have permenant identification and nameplate data tags? [ ]
2. Is the unit rated per the designed Air Volume of _____**CFM** ? [ ]
3. Does the Cooling Coil(s) Model No. match _____ and ? [ ]
4. Does the Heating Coil(s) Model No. match ? [ ]
5. Signed Drawings, Factory test sheets, & Fan curves delivered with Unit? [ ]
6. Are dampers sized per O & M design specifications? [ ]
7. Humidifier (If applicable) sized per O & M design specifications? [ ]
8. External & Internal Inspection complete No deficiencies found? [ ]
9. Is the unit sealed for on-site storage? [ ]

Pre Start-up Inspection. [ ]

1. All shipping bolts and tie downs removed? [ ]
2. Motors and motor housings fit well and are secured? [ ]
3. Is Return fan free to rotate by hand? [ ]
4. Is Supply fan free to rotate by hand? [ ]
5.. Are Sheaves and Drive Belts installed correctly and properly adjusted? [ ]
6. Free movement, proper sealing, and operation of Dampers. [ ]
7. Are humidifier (If applicable) pipes and drains fitted properly? [ ]
8. Access doors secure and all fasteners fully functional? [ ]
9. Are drains & eliminators fitted properly? [ ]
10. Inlet/discharge clear and guards secured if applicable ? [ ]
11. All safety and controls interlocks fitted correctly and proven at works? [ ]
12. Is the unit securely mounted and vibration isolation installed? [ ]

Checked/Tested by:	**Witnessed by:**
..... **Engineer** **For and on behalf of**	..... **Engineer** **For and on behalf of** .....

Project System …….. Date ……..	**Sheet No** **A 11**

Air Filter Check Sheet

Specification Details

1. AHU Ref .....
2. Filter Type and Manufacturer .....
3. Number of Cells .....
4. Size .....
5. Design Air Volume/CFM. .....
6. Design Pressure Drop/in wc .....

Pre-Commissioning Checks

1. Filter seal satisfactory ..... [ ]
2. Manometer fitted and complete ..... [ ]
3. Access doors secure ..... [ ]
4. AHU cleaned ..... [ ]
5. Filter direction correct ..... [ ]
6. Pre-filter fitted ..... [ ]

Commissioning Details

1. Measured flow rate/CFM .....
2. Measured pressure drop/in wc .....
3. Filter cleanliness .....

Comments

Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project... **Date**……. **System**……..…….. **Unit Ref** ….….....	**Sheet No A 12**

Fire Damper Check Sheet

Ref	Cleanliness	Manual Release OK	Reset/Link OK	Access Door OK	Initial	Comments

Tested by: .....**Engineer** **for and on behalf of**	**Witnessed by:** ..... **Engineer** **for and on behalf of** .....

Project System …….. Date ……..	Sheet No A 13

Motor Driven Fire/Smoke Damper Check Sheet

Reference	Correct Installation and Cleanliness of Damper & Actuator	Motor Open/Close OK	Fire Signal and Overrride OK	Access Door OK	Comments

Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Heery International Inc

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Project _____ Project Number _____ Date _____
System _____ Tested By _____ Page _____

Reference Factor (RF)
1. Flowhood 3
2. Multimeter/Pitot Tube 4

					Required		Test 1			Test 2			Test 3			Test 4		
ID No.	Room No.	Size	RF	Area	Velocity	CFM	Velocity	CFM	%	Velocity	CFM	%	Velocity	CFM	%	Velocity	CFM	%

Notes:

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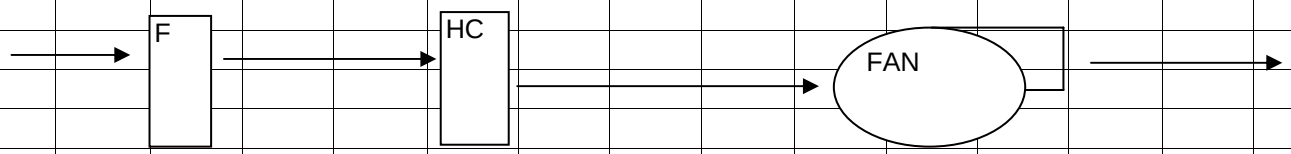
Project _____ Project Number _____ Date _____
System _____ Tested By _____ Page _____

FAN DATA		MOTOR DATA		STARTER DATA		DRIVE DATA	
Manufacturer		Manufacturer		Manufacturer		Fan Sheave	
Model		Horsepower		Type		Bushing/Bore	/
Serial No.		RPM		Size		Motor Sheave	
Type		Voltage		THERMAL OVERLOAD PROTECTION		Pitch Diamter/Max/Min	/ /
		Amperage		Built-into Motor	Y N	Bushing/Bore	/
		Phase		Overload Size		Center Distance	
		Service Factor		Overload Rating		CD +/- Adjustment	/
		Frame				Belts: Number/Size	/

		Entering		Leaving					Entering		CFM			Leaving						
Test 1																				
Test 2																				
Test 3																				
			DP			HC DP				RPM	DP	Volts		Amps						
Test 1																				
Test 2																				
Test 3																				



Notes:

Project ……	Sheet No
System …….. Date ……..	P 01

Plumbing Systems Commissioning Progress Status Sheet

The following are the necessary checks and tests to fully commission Plumbing systems.

Test Required	Sheet No	Signed and Witnessed
Plumbing Pipework Pressure Test	**P 02**	
Plumbing Installation Complete	**P 03**	
Plumbing System Pre-Commissioning Sheet	**P 04**	
Pre Start Electrical Checks	**E 08**	
Domestic Water Pump Test Sheet *(initial & final)*	**P 05**	
Domestic Water Test Sheet	**P 06**	
Domestic Water Chlorination Test Sheet	**P 07**	
Domestic Hot Water Calorifier Test Sheet	**P 08**	
Domestic Hot Water Appliance Water Flow Check Sheet	**P 09**	
Domestic Hot Water Regulation Check Sheet	**P 10**	
Domestic Hot Water Simultaneous Demand Test Sheet	**P 11**	
Drainage and Sanitary Ware Check Sheet	**P 12**	
Water Fill / Pressure Relief Proven	**Hand / Auto**	
Safety Stops Operation	**Hand / Auto**	
Control Valve Operation	**BMS**	
ΔP Switch Operation	**BMS**	
Duty Pump Rota Operation	**BMS**	
Sensor Calibration	**BMS**	
Temperature / Pressure Control Loops	**BMS**	
Flow Temperature Reset Control Loop	**BMS**	
Alarm & Monitoring Operation	**BMS**	

Authorization: .... System ready for Integrated Function Test Procedure.

Date. ..... **Signed**.....….....**Position**.....

For and on behalf of .....**Trade Contractor**

Project System …….. Date ……..	**Sheet No** **P 02**

Pipework Hydraulic Pressure Test Contractors Test No……

System Details

1. System .....
2. Section to be tested .....
3. Drawing No(s) .....
4. Test Method .....
5. Test Duration .....
6. Test Pressure.....

Test Details

1. Range of gauge - from..... to .....
2. Serial No .....
3. Calibration Certificate Reference.....
4. Date.....
5. Test Accepted .....[ ]

Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Heery International Inc

Project System …….. Date ……..	**Sheet No** **P 03**

(Plumbing) Installation Completion Check Sheet

1. Pipework installation complete and pressure tested **(P02)** ..... [ ]
2. Pumping equipment correctly installed and clean ..... [ ]
3. All water tanks positioned correctly in relation to drains & access ..... [ ]
4. All devices accessible ..... [ ]
5. Flow switches correctly fitted and operate ..... [ ]
6. Pressure reducing valves fitted, temperature test points fitted idetified ..... [ ]
7. Static flushing completed and system clean ..... [ ]
8. System filled and fully vented of air ..... [ ]
9. System maintained at working pressure (F&E tank/pressurization unit) ..... [ ]
10. All isolating/regulating valves left fully open, outlets fully closed ..... [ ]
11. All motorized valves positioned for flow through equipment ..... [ ]
12. Thermostatic mixing valves outlet heads removed and valves "capped" open ..... [ ]
13. Incoming water mains quality & purity test completed ..... [ ]
14. Incoming water mains pressure test completed ..... [ ]
15. Access provided in false ceiling/floor voids etc at each adjustable item ..... [ ]

Authorization: .... Installation complete and ready for startup.

Date. ..... **Signed**.....….....**Position** .....

For and on behalf of ..... **Trade Contractor**

Project System …….. Date ……..	**Sheet No** **P 04**

(Plumbing) Pre-Commissioning Check Sheet

			Comments
1	Pump and motor holding down bolts secure	[ ]	
2.	Pump correctly installed relative to water flow	[ ]	
3.	Pump and motor externally clean	[ ]	
4.	Flexible connections satisfactory	[ ]	
5.	Correct drive installed(where applicable)	[ ]	
6	Drive pulleys aligned and tight on shafts (where applicable)	[ ]	
7.	Drive belts tensioned (where applicable	[ ]	
8.	Guards correctly installed (where applicable)	[ ]	
9.	Pump free to rotate by hand	[ ]	
10.	Pump suction flooded and inlet valve open	[ ]	
11.	Gauges installed on pump suction and delivery	[ ]	
12.	All system valves open	[ ]	
13.	Pipework pressure testing complete	[ ]	
14.	Flushing complete	[ ]	
15.	System filled and vented	[ ]	
16.	System at normal static pressure	[ ]	
17.	Mains water available to system	[ ]	

18. Pre-start Electrical Check Sheet issued and signed. ....Sheet(s) **E 08/**.....Dated .....

19. Installation Completion Check Sheet issued and signed…Sheet(s) **P 03/**.....Dated .....

Authorization: .... System ready for TAB regulation.

Date. ..... **Signed**.....….....**Position**.....

For and on behalf of .....**Trade Contractor**

Project System …….. Date ……..	**Sheet No** **P 06**

Immersion/Water Heater Test Sheet

Static Checks

1. Pipework completed and witnessed see **P 01** ..... [ ]
2. Fixings and supports secure ..... [ ]
3. Vented taps fitted to under sink heaters ..... [ ]
4. Wiring completed and witnessed see **E 07** ..... [ ]
5. Thermostat operation dry check ..... [ ]

Dynamic Checks

1 System full of water and vented ..... [ ]

2. HWS pump commissioned see **P 03** ..... [ ]

Test Data

Position	Position 1 **Design**	Position 1 **Result**	Position 2 **Design**	Position 2 **Result**	Position 3 **Design**	Position 3 **Result**
Thermostat Setting	°F	°F	°F	°F	°F	°F
Secondary Water Temp	°F	°F	°F	°F	°F	°F
System Pressure	psi	psi	psi	psi	psi	psi

Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project System …….. Date ……..	**Sheet No** **P 07**

Domestic Water Chlorination Check Sheet

Outlet Ref	Pre-Chlorination	At Chlorination	After Chlorination		
	Water Visibly Clean	Chlorine Level	Chlorine Level	Outlet Sterilized	Laboratory Report and Comment
1	[ ]	ppm	ppm	[ ]	
2	[ ]	ppm	ppm	[ ]	
3	[ ]	ppm	ppm	[ ]	
4	[ ]	ppm	ppm	[ ]	
5	[ ]	ppm	ppm	[ ]	
6	[ ]	ppm	ppm	[ ]	
7	[ ]	ppm	ppm	[ ]	
8	[ ]	ppm	ppm	[ ]	
9	[ ]	ppm	ppm	[ ]	
10	[ ]	ppm	ppm	[ ]	
11	[ ]	ppm	ppm	[ ]	
12	[ ]	ppm	ppm	[ ]	
13	[ ]	ppm	ppm	[ ]	
14	[ ]	ppm	ppm	[ ]	
15	[ ]	ppm	ppm	[ ]	

Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project System …….. Date ……..	**Sheet No** **P 08**

Electric Water Heater Test Sheet

Static Checks

1. Safety valve fitted, correct setting and locked ..... [ ]
2. Drain cock installation with hose union ..... [ ]
3. Pressure gauge fitted with gauge cock ..... [ ]
4. Thermometer fitted and of correct range ..... [ ]
5. Fixing and supports secure ..... [ ]
6. Thermal insulation complete ..... [ ]
7. Thermostats at correct settings ..... [ ]
8. Water pre-commissioning checks complete see **P 01** ..... [ ]
9. Immersion heaters commissioned see **P 06** ..... [ ]
10. Chlorination checks completed see **P 07** ..... [ ]

Dynamic Checks

1. Control valve operational ..... [ ]
2. Circulating pumps commissioned see **P 03** ..... [ ]
3. System pressure satisfactory ..... [ ]

Test Data

	Design	**Result**		**Design**	**Result**
Thermostat Setting	°F	°F	Primary Water Flow	°F	°F
System Operating Press	psi	psi	Primary Water Return	°F	°F
Secondary Water Flow	°F	°F		°F	°F
Secondary Water Return	°F	°F		°F	°F

Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project System …….. Date ……..	**Sheet No** **P 09**

Hot Water Appliance Flow Check Sheet

1. Equipment .....
2. Manufacturer .....
3. Type/Model .....
4. Serial No .....
5. Rated Capacity .....kW

	Design	**Actual**
6. Entering Water Temperature	°F	°F
7. Leaving Water Temperature	°F	°F
8. Water Flow Rate	gpm	gpm
9. Inlet Pressure	psi	psi
10. Outlet Pressure	psi	psi
11. Pressure Drop	psi	psi

Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project ……	Sheet No
System …….. Date ……..	P 11

HWS Simultaneous Demand Test

1. With the system hot and under normal control with circulating pump running, open the index outlet fully.*..... [ ]
2. Open all other outlets fully to simulate the required simultaneous demand.* ..... [ ]
3. Fill vessel, record the time taken and calculate the flow rate per outlet..... [ ]
4. Close all outlets..... [ ]

* *Index outlet and all other simultaneous demand outlets to be advised by Consultant Engineer*

Location	Design gpm	Actual		
		Vessel Capacity	Time taken to fill	gpm
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				

Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Heery International Inc

Project System …….. Date ……..	**Sheet No** **P 12**

Drainage and Sanitary Ware Check Sheet

1. Soil stack water integrity / pressure test complete ..... [ ]
2. Sanitary ware and fittings secure and supported ..... [ ]
3. Sanitary ware without damage / cracks ..... [ ]
4. Cisterns correct action and water fill level ..... [ ]
5. Cisternmisers set correctly..... [ ]
6. Toilets and urinals flush correctly ..... [ ]
7. All basins and sinks drain correctly..... [ ]
8. Overflow piping complete ..... [ ]
9. Water integrity test to overflow piping..... [ ]
10. Waste piping to soil stack tested..... [ ]
11. Traps fitted to condensate piping..... [ ]

Comments .....

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project ……	Sheet No
System …….. Date ……..	P 13

Domestic Water Outlet Monitoring Sheet

Static Checks

1. Installation completion checks see **P 01**..... [ ]
2. Pre-commissioning checks completed see **P 02**..... [ ]
3. Calorifier/water heater completed see **P 06** ..... [ ]
4. Drainage installation completed and tested see **P 12** ..... [ ]
5. HWS Simultaneous Demand test completed see **P 10/P 11**..... [ ]
6. Chlorination check completed see **P 07** ..... [ ]

Dynamic Checks

1. Water flow available at all outlets ..... [ ]

Test Data

Tap/Shower Outlet	Design	Result	Tap/Shower Outlet	Design	Result
	°F	°F		°F	°F
	°F	°F		°F	°F
	°F	°F		°F	°F
	°F	°F		°F	°F
	°F	°F		°F	°F
	°F	°F		°F	°F
	°F	°F		°F	°F

Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Heery International Inc

Project System Date ……..	**Sheet No** **W 01**

Water Commissioning Progress Status Sheet

The following are the necessary checks and tests to fully commission each water system.

Test Required	Sheet No	Signed and Witnessed
Pipework Pressure Test	**W 02**	
Installation Complete	**W 03**	
Flushing Complete	**W 06**	
Inhibitor Glycol Added % Verified	**W 09**	
Pre-Commissioning Sheet	**W 04**	
Pre Start Electrical Checks	**E 08**	
Pump Test Sheet *(initial & final)*	**W 05**	
Water System Proportional Balance	**W 07**	
Plate Heat Exchangers *(where required)*	**W 08**	
Water Fill / Pressure Relief Proven	**Hand / Auto**	
Safety Stops Operation	**Hand / Auto**	
System Schematic Cx Sketch Sheet	**G 02**	
Control Valve Operation	**BMS**	
ΔP Switch Operation	**BMS**	
Duty Pump Rota Operation	**BMS**	
Sensor Calibration	**BMS**	
Temperature Control Loops	**BMS**	
Pressure Control Loops	**BMS**	
Freeze Protection Control Loop	**BMS**	
Flow Temperature Reset Control Loop	**BMS**	
Pump Run on Timer Operation	**BMS**	

Authorization: .... System ready for Integrated Function Test Procedure.

Date. ..... **Signed**.....….....**Position**.....

For and on behalf of CJ Hansen **Trade Contractor**

Heery International Inc

Project System …….. Date ……..	**Sheet No** **W 02**

Pipework Hydraulic Pressure Test Contractors Test No……..

System Details

1. System .....
2. Section to be tested .....
3. Drawing No(s) .....
4. Test Method .....
5. Test Duration .....
6. Test Pressure.....

Test Details

1. Range of gauge - from..... to .....
2. Serial No .....
3. Calibration Certificate Reference.....
4. Date.....
5. Test Accepted .....[ ]

Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Heery International Inc

Project System …….. Date ……..	**Sheet No** **W 03**

(Water) Installation Completion Check Sheet

1. Pipework installation complete and pressure tested **(W 02)** ..... [ ]
2. Pumping equipment correctly installed and clean ..... [ ]
3. All flow measuring devices positioned correctly in relation to water flow ..... [ ]
4. All tappings on flow measuring devices accessible ..... [ ]
5. Flow switches correctly fitted and operate ..... [ ]
6. Pressure / temperature test points fitted to all items of equipment ..... [ ]
7. Static flushing completed and system clean ..... [ ]
8. System filled and fully vented of air ..... [ ]
9. System maintained at working pressure (F&E tank/pressurization unit) ..... [ ]
10. All isolating/regulating valves left fully open ..... [ ]
11. All motorized valves positioned for flow through equipment ..... [ ]
12. Thermostatic radiator valve heads removed and valves "capped" open ..... [ ]
13. All in-line Suction diffusers fitted with correct mesh and sufficient clearance provided ..... [ ]
14. Personnel available for strainer cleaning etc following initial circulation ..... [ ]
15. Access provided in false cleaning/floor voids etc at each adjustable item ..... [ ]

Authorization: .... Installation complete and ready for startup.

Date. ..... **Signed**.....….....**Position** .....

For and on behalf of ..... **Trade Contractor**

Project System …….. Date ……..	**Sheet No** **W 04**

(Water) Pre-Commissioning Check Sheet

			Comments
1	Pump and motor holding down bolts secure	[ ]	
2.	Pump correctly installed relative to water flow	[ ]	
3.	Pump and motor externally clean	[ ]	
4.	Flexible connections satisfactory	[ ]	
5.	Correct drive installed(where applicable)	[ ]	
6	Drive pulleys aligned and tight on shafts (where applicable)	[ ]	
7.	Drive belts tensioned (where applicable	[ ]	
8.	Guards correctly installed (where applicable)	[ ]	
9.	Pump free to rotate by hand	[ ]	
10.	Pump suction flooded and inlet valve open	[ ]	
11.	Gauges installed on pump suction and delivery	[ ]	
12.	All system valves open	[ ]	
13.	Pipework pressure testing complete	[ ]	
14.	Flushing and chemical cleaning complete	[ ]	
15.	System filled and vented	[ ]	
16.	System at normal static pressure	[ ]	
17.	Mains water available to system	[ ]	

18. Pre-start Electrical Check Sheet issued and signed. ..... ….Sheet(s) **E 08/**.....Dated .....

19. Installation Completion Check Sheet issued and signed…Sheet(s) **W 03/**.....Dated.....

Authorization: .... System ready for TAB regulation.

Date. ..... **Signed**.....….....**Position**.....

For and on behalf of .....**Trade Contractor**

Project System …….. Date ……..	**Sheet No** **W 06**

Flushing Record Sheet

1. Date Method Statement received ..... [ ]
2. Method Statement approved by..... [ ]
3. System pumps or external pumps ..... [ ]
4. Method of water make up available ..... [ ]
5. Drainage connected..... [ ]
6. Chemicals approved by Water Authority and compatibility with system materials..... [ ]
7. Flushing velocity Design..... ....gpm Actual.....gpm ..... [ ]
8. System pressure test sheets completed..... [ ]
9. System capacity Design..... gpm Actual..... gpm ..... [ ]
10. Flushing loops connected ..... [ ]
11. Spades inserted or part system valved off..... [ ]
12. Static drain ..... [ ]
13. Suction Diffusers correct size and grade of baskets ..... [ ]
14. Dynamic flushing period from……/……/…….. to……/……/……[ ]
15. Dead legs flushed through to drain with clean water..... [ ]
16. Samples taken until suspended solids at less than 6 ppm..... [ ]
17. Suction Diffusers removed & cleaned..... [ ]
18. Cleaning chemical circulated ..... [ ]
19. Samples taken until iron content plateau achieved ..... [ ]
20. System diluted until iron content less than 1ppm or within 10% of Mains water..... [ ]
21. Time inhibitor added, type used, duration solution in contact ..... [ ]
22. Samples taken until correct percentage achieved..... [ ]
23. System reconfigured to normal operation..... [ ]

Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Heery International Inc

Project …… System …….. Date ……..	**Sheet No** **W 08**

Plate Heat Exchanger Test Sheet

Static Checks

1. Fixings and supports secure ..... [ ]
2. Pipework connections correct ..... [ ]
3. Suction diffuser fitted on inlets ..... [ ]
4. Control valve/actuator fitted and wired ..... [ ]
5. Pipework pressure tested & Flusheing completed and witnessed see **W 02 / W 06** ..... [ ]
6. Control sensors fitted ..... [ ]
7. Pressure Test points fitted ..... [ ]

Dynamic Checks

1. Suction diffuser baskets cleaned ..... [ ]
2. Control valve operational ..... [ ]
3. Proportional balance completed see **W 07** ..... [ ]

Test Data

	Design	**Result**		**Design**	**Results**
Primary Water			Secondary Water		
Temperature In	°F	°F	Low Grade Temp In	°F	°F
Temperature Out	°F	°F	Low Grade Temp Out	°F	°F
Flow Rate	gpm	gpm	Low Grade Flow Rate	gpm	gpm

Comments

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Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

Project System …….. Date ……..	**Sheet No** **W 09**

Inhibitor / Glycol Level Test Sheet

Design Details

1. System Content ..... gallons
2. Design Temperature (MWT) ..... °F
3. Design Inhibitor Level .....%…… Design Glycol Level ……%

Test Details

1. Actual measured Inhibitor Level ..... %…… Glycol Level ……%
2. Mean Water Temp at time of test ..... °F
3. Test Location .....

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Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Heery International Inc

Project ……	Sheet No
System …….. Date ……..	E 01

Electrical Systems Commissioning Progress Status Sheet

The following are the necessary checks and tests to fully commission electrical systems.

Test Required	Sheet No	Signed and Witnessed
LV / MV Main Cable Inspection /Test Sheet	**E 02**	
Power Cables - Continuity & Insulation Resistance of 3 & 4 core Cables Test Sheet	**E 03**	
Main Distribution Panel Inspection /Test Sheet	**E 04**	
Application for Energization of Main LV Switch Board	**E 05**	
Application for Energization of LV Distribution panel	**E 06**	
Insulation Resistance & Polarity Test Sheet	**E 07**	
Motors Pre-Start Electrical Check Sheet	**E 08**	
Lighting & Small Power Inspection Check Sheet	**E 09**	
Control Cable Installation Inspection Check Sheet	**E 10**	
Control Panel & Control Circuit Check Sheet	**E 11**	
Illumination Levels Record Sheet	**E 12**	
Emergency Lighting Test Record Sheet	**E 13**	
Generator System Check Sheets	**E 14**	
Generator Fuel Systems Check Sheet	**E 15**	
Safety Stops and Interlock Operation	**Hand / Auto**	
Transfer Switch Operation	**Auto**	
Emergency Power Operation	**Auto**	
Plant List Functions on Emergency Power Operation	**Auto**	
System Cx Schematic Sketch Sheet	**G 02**	
BMS Meter Monitoring and Alarm Functions	**BMS**	

Comments

Authorization: .... System ready for Integrated Function Test Procedure.

Date. ..... **Signed**.....….....**Position**.....

For and on behalf of .....**Trade Contractor**

Project …… System …….. Date ……..	**Sheet No** **E 02**

LV/MV Cable Inspection/Test Sheet

Inspection

1.	**Associated equipment fitted**.....	**[ ]**	**10.**	**Spreader box layout satisfactory**.....	**[ ]**
2.	**Cable identification correct**.....	**[ ]**	**11.**	**Sealing washers fitted correctly**.....	**[ ]**
3.	**Installed length**.....	**ft**	**12.**	**Earth tags fitted and bonded correctly**.....	**[ ]**
4.	**Voltage grade correct**.....	**[ ]**	**13.**	**Armour/screen earthed correctly**.....	**[ ]**
5.	**Cable type correct**.....	**[ ]**	**14.**	**Core Indents & ferrules fitted correctly**....	**[ ]**
6.	**Cores and cross section correct**.....	**[ ]**	**15.**	**Cables lugs fitted & secure - End 'A'**.....	**[ ]**
7.	**Cables dressed and clipped correctly**.....	**[ ]**		.....**End 'B'**.....	**[ ]**
8.	**Bending radii acceptable**.....	**[ ]**	**16.**	**Terminations insulated**.....	**[ ]**
9.	**Gland plates/shrouds etc correct - End 'A'**	**[ ]**	**17.**	**Mechanical protection satisfactory**.....	**[ ]**
	..... **End 'B'**	**[ ]**	**18.**	**Installed in accordance with Drgs & Spec**.	**[ ]**

Testing

Instrument Serial No.....

Instrument Calibration Date.....

Test voltage.....

Continuity and phasing correct.....**YES/NO**

Insulation resistance see sheet E10/.....

P-N/P-E loop impedance see sheets E15/.....

Cables reconnected.....**YES/NO**

Comments

Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

Project ……..

System …….. Date ……..

Power Cables - Continuity & Insulation Resistance of 3 & 4 Core Cables Test Sheet

Cable Number	Insulation resistance (M.Ohms)				Continuity of cores (Ohms)									
	R- Y,B,N & Grnd	Y- R,B,N & Grnd	B- R,Y,N & Grnd	N- R,Y,B & Grnd	R	(R + Y)/2	Y	(Y + B)/2	B	(B + R)/2	N	(N + R)/2	Grnd	(R+Grnd) - R

Test Instrument			
	1. Name.....	**Manufacturer**.....	**Model No.**.....
	Serial No.....	**Calibration Certificate No.**	**Calibration Date**.....
	2. Name.....	**Manufacturer**.....	**Model No.** .....
	Serial No.....	**Calibration Certificate No.**	**Calibration Date**.....

Checked/Tested by:

..... **Engineer**

For and on behalf of .....

Witnessed by:

.....**Engineer**

For and on behalf of .....

Sheet No E 03

Heery International Inc

Project …… System …….. Date ……..	**Sheet No** **E 04**

Main Distribution Panel Inspection/Test Sheet

Switchboard Tag No.....… **Equipment Tag No**.....

Switchboard Unit Reference..... **Equipment Reference**.....
.

Equipment Duty..... **Equipment Rating**.....

Switchboard Location..... **Nominal Voltage**.....

Manufacturer..... **Drawing No**.....

Inspection

1.	**As approved drawing**.....	[ ]	**11.**	**All transit packing materials removed**.....	[ ]
2.	**Suitable for area classification**.....	[ ]	**12.**	**Mechanically undamaged**.....	[ ]
3.	**Aligned and foundation bolts secure**.....	[ ]	**13.**	**Doors fit/open-close correctly**.....	[ ]
4.	**Busbar supports adequate and secure**.....	[ ]	**14.**	**Door ground connection satisfactory**.....	[ ]
5.	**Busbar terminals checked and tight**.....	[ ]	**15.**	**Mech. operation of isolator MCB correct**....	[ ]
6.	**Internal wiring satisfactory**.....	[ ]	**16.**	**Mech. operation of contactor correct**.....	[ ]
7.	**Wiring identification satisfactory**.....	[ ]	**17.**	**Padlocking facilities correct**.....	[ ]
8.	**Wiring terminations tight**.....	[ ]	**18.**	**Indicating lamps operate**.....	[ ]
9.	**Capacity and rating of devices correct**.....	[ ]	**19.**	**Designation labels correct**.....	[ ]
10.	**All transit bolts removed**.....	[ ]	**20.**	**Panel clean and dry**.....	[ ]

Testing

Instrument Serial No..... **Instrument Calibration Date**.....

Test voltage..... **Continuity & phasing correct**.....**YES/NO**

P-N/P-E loop impedance see sheets E15/.....

Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project …… System …….. Date ……..	**Sheet No** **E 05**

Application to Energize Main Low Voltage Switch Panel

For Electrical Contractors Use

1. **Panel**.....
2. **Date Energization Required**.....**Time**.....
3. **Authorized Person after Energization**.....**(Print Name)**
4. **"Permit to Work" in place** **[ ]**
5. **Signed by**..... **Print Name**.....

   for and on behalf of.....

The following tests are to be undertaken/verified prior to energization	**Test Sheet**	**Status**
1. Earth Fault Loop Impedance at HV/LV Transformer LV terminals.	**E**...../...../.....	
2. Prospective Short Circuit Current at HV/LV Transformer LV terminals.	**E**...../...../.....	
3. Test sheets for all cables from LV terminals to main LV switch panel and earth continuity.	**E**...../...../.....	
4. Test sheets for site test of HV/LV Transformer.	**E**...../...../.....	
5. Test sheets for site test of main LV switch panel.	**E**...../...../.....	
6. All outgoing circuits locked in the off position.	**E**...../...../.....	

Comments

Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

Project ……	Sheet No
System …….. Date ……..	E 06

Application to Energize Low Voltage Distribution Board

For Electrical Contractors Use

1. **DB #**.....
2. **Date Energization Required**.....**Time**.....
3. **Authorized Person after Energization**.....**(Print Name)**
4. **"Permit to Work" in place** **[ ]**
5. **Signed by**..... **Print Name**.....

   for and on behalf of.....

The following tests are to be undertaken/verified prior to energization	Test Sheet	Status
1. Test sheets for all cables from DB terminals to circuits and ground continuity tests.	E...../...../.....	
2. Test sheets for test of main LV switch panel feeder cable to DB.	E...../...../.....	
3. All outgoing circuits locked in the off position.	E...../...../.....	

Comments

Checked/Tested by:	Witnessed by:
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project

System …….. Date …….

Insulation Resistance and Polarity Test Sheet

Distribution Board Ref.....

Phase.....
Type.....

Location.....
Voltage.....

Distribution Board/Circuit	Red - Y,B,N & Grnd	Yellow - R,B,N & Grnd	Blue - R,Y,N & Grnd	Neutral - R,Y,B & Grnd	Polarity	General Comments

Test Instruments

1. Name..... **Manufacturer**..... **Model No.** .....……
Serial No.....……. **Calibration Certificate No.** ..... **Calibration Date**.....……

2. Name..... **Manufacturer**..... **Model No.** .....……..
Serial No.....……. **Calibration Certificate No.** ..... **Calibration Date**.....……

Checked/Tested by:

.....……..……..... **Engineer**

For and on behalf of…….....….....

Witnessed by:

.....……..……...……..…….....**Engineer**

For and on behalf of .....…….....

Sheet No E 07

Heery International Inc

Project System …….. Date ……..	**Sheet No** **E 08**

Motor Pre-Start Electrical Check Sheet

Wiring Checks	**Comment**
1. Cable(s) complete from panel to local isolator ..... YES/NO	
2. Visual check that cables(s) are satisfactory ..... YES/NO	
3. Cable complete from local isolator to drive ..... YES/NO	
4. Power factor correction capacitor correctly installed ..... YES/NO	
5. Cabling completed for control circuit interlock..... YES/NO	
6. Grounding to surrounding metalwork is complete ..... YES/NO	
7. Continuity test satisfactory ..... YES/NO	
8. Danger/warning labels fitted..... YES/NO	
9. Insulation resistance test satisfactory ..... YES/NO	
10. Ground loop impedance test satisfactory..... YES/NO	

Panel/Starter Checks	**Comment**
1. Continuity of cables in accordance with wiring diagrams ..... YES/NO	
2. Cables connected correctly in control panel..... YES/NO	
3. Dry run checks on starter satisfactory..... YES/NO	
4. Fuses of correct type and rating fitted..... YES/NO	

Safety Checks	**Comment**
1. Warning labels for "Automatic Start" etc fitted ..... YES/NO	
2. Motor insulation resistance satisfactory ..... YES/NO	
3. Checked and set overload to plated FLC..... YES/NO	
4. Dry check phase rotation satisfactory ..... YES/NO	
5. Safety checks on drive equipment complete..... YES/NO	
6. Motor rotation and general running condition correct..... YES/NO	

Authorization: .... Clearance is now given for drive to operate.

Date.....**Signed**.....….....**Position**

For and on behalf of ..... **Trade Contractor**

Project …… System …….. Date ……..	**Sheet No** **E 09**

Lighting and Small Power Inspection/Test Sheet

Inspection

1. Installed in accordance with Dwgs & Spec..	[ ]	**7. Paint finish satisfactory**.....	[ ]
2. Suitable for area classification.....	[ ]	**8. Equipment installed correctly**.....	[ ]
3. Circuit rating and number verified.....	[ ]	**9. Fittings installed as per relevant drawings**	[ ]
4. Feeder cable size.....	[ ]	**10. Sub-circuits fuse rating**.....	**amps**
5. Equipment grounding satisfactory.....	[ ]	**11. All cables numbered**.....	[ ]
6. Cable earth tags installed.....	[ ]	**12. All cable cores numbered**.....	[ ]

Testing

Test voltage.....

Insulation resistance see sheets E07/.....

Continuity and phasing correct.....……..**YES/NO**

Comments

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Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

Project …… System …….. Date ……..	**Sheet No** **E 10**

Control Cable Installation Inspection/Test Sheet

Inspection

1.	**Associated equipment fitted**.....	**[ ]**	**10.**	**Terminal box layout satisfactory**.....	**[ ]**
2.	**Cable identification correct**.....	**[ ]**	**11.**	**Sealing washers fitted correctly**.....	**[ ]**
3.	**Installed length**.....	**mtrs**	**12.**	**Earth tags fitted and bonded correctly**.....	**[ ]**
4.	**Voltage grade correct**.....	**[ ]**	**13.**	**Armour/screen earthed correctly**.....	**[ ]**
5.	**Cable type correct**.....	**[ ]**	**14.**	**Indents and ferrules fitted correctly**.....	**[ ]**
6.	**Cores and cross section correct**.....	**[ ]**	**15.**	**Cables lugs fitted & secure - End 'A'**.....	**[ ]**
7.	**Cables dressed and clipped correctly**.....	**[ ]**		.....**End 'B'**.....	**[ ]**
8.	**Bending radii acceptable**.....	**[ ]**	**16.**	**Terminations insulated**.....	**[ ]**
9.	**Gland plates/shrouds etc correct - End 'A'**	**[ ]**	**17.**	**Mechanical protection satisfactory**.....	**[ ]**
	..... **End 'B'**	**[ ]**	**18.**	**Installed in accordance with Dwgs & Spec**	**[ ]**

Testing

Instrument Serial No.....

Instrument Calibration Date.....

Insulation resistance between cores (lowest value) .....**ohms**

Insulation resistance cores to earth (lowest value) .....**ohms**

Test voltage.....

Continuity & phasing correct.....**YES/NO**

Cables reconnected.....**YES/NO**

Comments

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Checked/Tested by:	**Witnessed by:**
..... **Engineer**	..... **Engineer**
For and on behalf of	**For and on behalf of** .....

Project …… System …….. Date ……..	**Sheet No** **E 11**

Control Circuit/Panel Check Sheet

1. **Nameplate correct**..... [ ]
2. **Area Classification correct**..... [ ]
3. **Terminal rails correctly installed and accessible**..... [ ]
4. **Outgoing terminals clearly marked**..... [ ]
5. **All panel doors close and fit correctly**..... [ ]
6. **All components securely fixed and free from damage**..... [ ]
7. **Connections to ground bars inside secure**..... [ ]
8. **Connections to external grounding systems secure**..... [ ]
9. **All internal wiring connections secure**..... [ ]
10. **All panel instruments clearly tagged**..... [ ]
11. **All fuse ratings correct as per drawings**..... [ ]
12. **All interlocks checked and witnessed**..... [ ]

Comments

.....

.....

.....

.....

Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

Project ……

System …….. Date …….

Emergency Lighting Test Sheet

Location of Luminaire	Type B = Bulkhead F = Fluorescent	Status N = Non-Maintained M = Maintained	Specified Battery Duration	Operational Voltage	Duration Under Test	Operation of Automatic Features

Checked/Tested by:

..... **Engineer**

For and on behalf of .....

Witnessed by:

.....**Engineer**

For and on behalf of .....

Sheet No E 13

Heery International Inc

Project ……	Sheet No
System …….. Date ……..	E 01

Electrical Systems Commissioning Progress Status Sheet

The following are the necessary checks and tests to fully commission electrical systems.

Test Required	Sheet No	Signed and Witnessed
LV / MV Main Cable Inspection /Test Sheet	**E 02**	
Power Cables - Continuity & Insulation Resistance of 3 & 4 core Cables Test Sheet	**E 03**	
Main Distribution Panel Inspection /Test Sheet	**E 04**	
Application for Energization of Main LV Switch Board	**E 05**	
Application for Energization of LV Distribution panel	**E 06**	
Insulation Resistance & Polarity Test Sheet	**E 07**	
Motors Pre-Start Electrical Check Sheet	**E 08**	
Lighting & Small Power Inspection Check Sheet	**E 09**	
Control Cable Installation Inspection Check Sheet	**E 10**	
Control Panel & Control Circuit Check Sheet	**E 11**	
Illumination Levels Record Sheet	**E 12**	
Emergency Lighting Test Record Sheet	**E 13**	
Generator System Check Sheets	**E 14**	
Generator Fuel Systems Check Sheet	**E 15**	
Safety Stops and Interlock Operation	**Hand / Auto**	
Transfer Switch Operation	**Auto**	
Emergency Power Operation	**Auto**	
Plant List Functions on Emergency Power Operation	**Auto**	
System Cx Schematic Sketch Sheet	**G 02**	
BMS Meter Monitoring and Alarm Functions	**BMS**	

Comments

Authorization: .... System ready for Integrated Function Test Procedure.

Date. ..... **Signed**.....….....**Position**.....

For and on behalf of .....**Trade Contractor**

Project ……	Sheet No
System …….. Date ……..	E 14-1

Sign Off Sheet -- Emergency Generator Systems

Unit Number:

Warranty Start:	Submitted	Approved	Comments
Installation and Startup Checklist			
Sequences and Control Strategies			
Performance Data (fan curves, etc.)			
Manufacturers Test Report Submitted			
Training			
O and M Manuals			

Equipment Verification

Equipment data	Design	Submitted	Nameplate
Mfr:			
Model:			
Serial:			
Capacity KW:			
Volts:			
Phase:			
Amps:			
Power Factor:			

The Installation Checklist has been completed and is ready for start up.

Test Engineer Date Contractor Date Commissioning Agent Date

The Operational Checklist has been completed and equipment is ready for functional testing.

Test Engineer Date Contractor Date Commissioning Agent Date

Functional Testing has been completed and meets specification and design intent. All documentation and training has been received and is satisfactory except as noted in Deficiency List. I recommend acceptance of equipment.

Test Engineer Date Contractor Date Commissioning Agent Date

Project ……	**Sheet No**
System …….. Date ……..	**E 14-2**

Installation Checklist -- Emergency Generator

Unit Name

- ☐ Mfr installation checklist completed
- ☐ Seismic restraints in place
- ☐ Vibration isolation devices installed and functional
- ☐ Equipment is level
- ☐ Equipment labels affixed
- ☐ Safeties installed
- ☐ Equipment properly grounded
- ☐ Pipe fittings complete and pipes properly supported
- ☐ Start up filters installed and replacements on hand
- ☐ Piping flushed and tested for leaks
- ☐ Valve tags in place
- ☐ Fuel piping complete and pressure tested
- ☐ Fuel pressure regulating valve installed
- ☐ Fuel/water separators with filters installed
- ☐ Lube oil pump with filters installed
- ☐ Lube oil bypass installed to turbocharger
- ☐ Oil level per manufacturer's instruction
- ☐ Equipment condition good, no apparent damage
- ☐ Smoke detectors installed
- ☐ Inspection complete on expansion tank
- ☐ ASME pressure vessel data sheet posted
- ☐ Water temperature control valves connected
- ☐ Pipes properly insulated
- ☐ Coolant system filled
- ☐ Glycol concentration at specification
- ☐ Jacket Heater system installed
- ☐ Batteries and charger installed
- ☐ Exhaust system complete with silencer
- ☐ PLC programming complete
- ☐ Fire extinguishing/alarm system complete
- ☐ Control sequence, strategy, setpoint list provided w/
- ☐ Control wiring system hooked up
- ☐ Specified point-to-point checks completed
- ☐ All controls installed and functioning
- ☐ Adequate maintenance access
- ☐ Fuel Quality Tests satisfactory
- ☐ Lock out/Tag out system used properly

Comments:

Project ……	**Sheet No**
System …….. Date ……..	**E 14-3**

Operational Checklist -- Emergency Generator

Unit Name

- ☐ Manufacturer's Start-Up report completed and submitted
- ☐ Lock out/Tag outs completed or cleared as appropriate
- ☐ No fuel leaks
- ☐ No water leaks
- ☐ No oil leaks
- ☐ No exhaust leaks
- ☐ Battery charger rate of charge within manufacturer's specification
- ☐ Oil pressure within manufacturer's specification
- ☐ Water temperature within specification
- ☐ Jacket water heating system operational
- ☐ Fuel pressure within specification
- ☐ No grounds indicated
- ☐ No unusual noise or vibration
- ☐ Insulation resistance test results submitted
- ☐ NETA ATS inspection for generator sets submitted

Comments:

Project ……	Sheet No
System …….. Date ……..	E 14-4

Functional Checklist – Emergency Generator

Unit Name:

- ☐ Test instruments calibrated
- ☐ New filters installed and strainers cleaned
- ☐ Generator starts automatically
- ☐ Comes up to speed, voltage and frequency in 10 seconds
- ☐ Phase rotation correct (CCW)
- ☐ Lead coolant pump starts in automatic
- ☐ Radiator fan starts in automatic
- ☐ Lag pump starts on lead pump failure
- ☐ Temperature Control Valve (TCV) modulates to maintain
- ☐ Fan speed modulates to maintain temp
- ☐ HX TCV modulates to maintain temp
- ☐ Back-up HX starts automatically upon failure of primary
- ☐ Back-up HX TCV modulates to maintain temp
- ☐ Fuel pressure regulating valve maintains manifold pressure
- ☐ Fuel Oil Cooler TCV modulates to maintain temp
- ☐ Transient voltage variation less than 20% during step load
- ☐ Transient frequency variation less than 5% during step load
- ☐ Engine maintains speed at steady state
- ☐ No excessive hunting of engine speed during step load
- ☐ Low oil pressure alarm works
- ☐ High water temperature alarm works
- ☐ Low water temperature alarm works
- ☐ Automatic load shedding occurs in sequence when load >90% 1 hour
- ☐ Emergency stop works
- ☐ Over speed trip works
- ☐ Emergency stop works
- ☐ Manual bus tie shift functional
- ☐ Fan speed increases at 160F water supply temp
- ☐ Day tank low fuel level alarm works
- ☐ Day tank high fuel level alarm works
- ☐ Battery charger failure alarm works
- ☐ Low-low oil pressure shutdown works
- ☐ High-high water temperature shutdown works
- ☐ Protective relay trip works
- ☐ Engine locked out shutdown works
- ☐ PLC failure shutdown works
- ☐ DC Control voltage failure shutdown works
- ☐ Fan at full speed at 180F
- ☐ Fan speed decreases at 178F (decreasing)
- ☐ Fan speed at minimum at 158F (decreasing)
- ☐ Fan stops after time delay when “Engine Off”
- ☐ Fan operates at full voltage with VFD in bypass
- ☐ Pumps stop after time delay when “Engine Off”
- ☐ Emissions test satisfactory
- ☐ Vibration baseline test within mfr’s limits and report submitted
- ☐ Surface temperature tests satisfactory

Project ……	Sheet No
System …….. Date ……..	E 14-5

Operational Checklist—Emergency Generator

	50% Load (1 hour)				75% Load (1 hour)				100% Load (2 hours)			
	Design	1	2	3	Design	1	2	3	Design	1	2	3
KW												
Voltage												
Amps												
Power Factor												
Frequency												
Harmonic Content												
Engine RPM												
Winding Temperature												
Exhaust System Backpressure												
Oil Temperature												
Oil Pressure												
Radiator water inlet temp												
Radiator water outlet temp												
Radiator Water GPM												
HX Jacket Water inlet temp												
HX Jacket Water outlet temp												
Jacket Water GPM												
Fan RPM												
Fuel Oil Cooler inlet temp												
Fuel Oil Cooler outlet temp												
Fuel Oil Cooler TCV position												
Noise level (dB)												
Fuel consumption (GPM)												

Functional Checklist – Emergency Generator

Battery Tests

	Full charging	Float charging
Electrolyte level		
Specific gravity		
Charging Voltage		
Voltage between terminals		

Project ……	**Sheet No**
System …….. Date ……..	**E 14-6**

Sign-Off Sheet – Jacket Water Pump

Unit Name:

Warranty start date:	Submitted	Approved	Comments
Installation and startup checklist			
Sequences and control strategies			
Performance data			
TAB Report			
Training			
O & M Manuals			

Equipment Data:	Design	Submitted	Nameplate
Manufacturer:			
Model #:			
Serial #:			
Capacity GPM:			
Head (psi):			
Impeller size (in):			
Motor Manufacturer:			
Motor HP:			
Motor Serial #:			
Power (Volt/Phase/HZ):			
FLA:			
Frame Number			

The Installation Checklist has been completed and is ready for start up.

Test Engineer Date Contractor Date Commissioning Agent Date

The Operational Checklist has been completed and equipment is ready for functional

Test Engineer Date Contractor Date Commissioning Agent Date

Functional Testing has been completed and meets specification and design intent. All documentation and training has been received and is satisfactory except as noted in Deficiency List. I recommend acceptance of equipment.

Test Engineer Date Contractor Date Commissioning Agent Date

Project ……	**Sheet No**
System …….. Date ……..	**E 14-7**

Installation Checklist -- Jacket Water Pump

Unit Name:

- ☐ Mfr installation checklist completed
- ☐ Seismic restraints in place
- ☐ Vibration isolation devices installed and functional
- ☐ Pump and motor aligned
- ☐ Pump and motor properly lubricated
- ☐ Motor efficiency verified
- ☐ Electrical equipment grounded per specification
- ☐ Power disconnects in place and labeled
- ☐ HOA/ manual/ off switches installed
- ☐ Safeties installed
- ☐ Junction boxes closed or covers installed
- ☐ Pipefittings complete and pipes properly supported
- ☐ Strainers in place and clean
- ☐ Control sequence, strategy, setpoint list provided w/ values
- ☐ Control wiring system hooked up
- ☐ Specified point-to-point checks completed
- ☐ All controls installed and functioning
- ☐ Self contained unit controls installed and functioning
- ☐ Unit control panel and display installed and functional
- ☐ Equipment condition good, no apparent damage
- ☐ Equipment labels affixed
- ☐ Adequate maintenance access

Comments:

Project ……	**Sheet No**
System …….. Date ……..	**E 14-8**

Operational Checklist -- Jacket Water Pump

Unit Name:

- ☐ HOA switch properly activates/deactivates the unit
- ☐ Pump rotation correct
- ☐ No unusual noise or vibration when running
- ☐ No leaks
- ☐ Isolation valves operate properly
- ☐ Manufacturer's Start-up report completed and submitted
- ☐ CC submitted point-to-point document
- ☐ Test and Balance sheet (TAB) completed and submitted

Comments:

Functional Checklist – Condenser Water Pump

Unit Name:

Activate pump start using control system commands (all possible combinations, on/auto, etc)
Verify and record pressure drop across strainer.

Strainer inlet pressure PSIG:	
Strainer outlet pressure PSIG:	

Operate pump at shut off and full flow. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

	Shut Off	100%
Pump inlet pressure PSIG:		
Pump outlet pressure PSIG:		
Pump flow rate GPM:		
Volts		
Amps		
Pump BHP		
Pump RPM		

Verify motor amperage each phase and voltage phase to phase and phase to ground.

Amperage Phase A		
Amperage Phase B		
Amperage Phase C		
Voltage Phase A-B		Imbalance <2%
Voltage Phase B-C		Imbalance <2%
Voltage Phase C-A		Imbalance <2%
Voltage to Ground:		

Comments:

Project ……	Sheet No
System …….. Date ……..	E 14-9

Sign-Off Sheet -- Radiator

Unit Name:

Warranty Start Date:	Submitted	Approved	Comments
Installation and Startup checklist			
Sequences and control strategies			
Performance data			
TAB Report			
Training			
O & M Manuals			

Equipment Verification

Equipment data	Design	Submitted	Actual
Manufacturer:			
Model:			
Serial #			
Capacity BTU/min			
Fan Manufacturer:			
Fan Model:			
Frame number:			
CFM:			
Motor HP:			
Power (Volts/Phase/Hz):			
FLA:			
Frame Number			

The Installation Checklist has been completed and is ready for start up.

Test Engineer Date Contractor Date Commissioning Agent Date

The Operational Checklist has been completed and equipment is ready for functional

Test Engineer Date Contractor Date Commissioning Agent Date

Functional Testing has been completed and meets specification and design intent. All documentation and training has been received and is satisfactory except as noted in Deficiency List. I recommend acceptance of equipment.

Test Engineer Date Contractor Date Commissioning Agent Date

Project ……	**Sheet No**
System …….. Date ……..	**E 14-10**

Installation Checklist -- Radiator

Unit Name

- ☐ Mfr installation checklist completed
- ☐ Seismic restraints in place
- ☐ Equipment labels affixed
- ☐ Fan(s) and motor aligned, belt tensioned
- ☐ Belt guard in place and secure
- ☐ Fan(s) and motor properly lubricated
- ☐ Motor efficiency verified
- ☐ Correct over-current heater in motor starter installed
- ☐ Temperature and flow sensors installed
- ☐ Electrical equipment grounded per specification
- ☐ Power disconnects in place and labeled
- ☐ HOA/ manual/ off/ VFD switches installed
- ☐ Junction boxes closed or covers installed
- ☐ Equipment condition good, no apparent damage
- ☐ Vibration isolation devices installed and functional
- ☐ Adequate maintenance access
- ☐ Pipe fittings complete and pipes properly supported
- ☐ Piping flushed and tested for leaks
- ☐ Strainers in place and clean
- ☐ Temp and pressure gages installed
- ☐ Expansion tank installed and labeled
- ☐ Inspection complete on expansion tank
- ☐ ASME pressure vessel data sheet posted
- ☐ Glycol concentration at specification
- ☐ Coils clean and in good condition
- ☐ Temp control valves installed in proper direction
- ☐ Pipes properly insulated
- ☐ Control sequence, strategy, setpoint list provided w/ values
- ☐ Control wiring system hooked up
- ☐ Specified point-to-point checks completed
- ☐ Unit control panel and display installed and functional

Comments:

Project ……	**Sheet No**
System …….. Date ……..	**E 14-11**

Operational Checklist -- Radiator

Unit Name

- ☐ HOA switch activates/deactivates the fan
- ☐ Fan rotation correct
- ☐ No unusual noise or vibration
- ☐ No water leaks
- ☐ Expansion tank charged
- ☐ Manufacturer's start-up report completed and submitted
- ☐ Test, Adjust, & Balance report submitted

Fuse rating:	
Number of belts	
Part #:	

Comments:

Functional Checklist - Radiator

Operate fan at full load and take following readings. Plot data on fan curve and compare.

	Design	Measured
Max CFM		
RPM		
Voltage A-B		
Voltage A-C		
Voltage B-C		
Voltage to ground		
Amps A		
Amps B		
Amps C		

Comments:

Project …… System …….. Date ……..	**Sheet No** **E 15**

Generator Fuel System Check Sheet

Item	Item Description	Comments	Completed
1	Storage tank complete, clean and tested		
2	Storage tank equipment installed		
3	Day tank complete, clean and tested		
4	Day tank equipment installed		
5	Connecting pipework and pipeline equipment installed and tested		
6	Fire Valves wired and checked		
7	Solenoid Valves wired and checked		
8	Pipeline main filter fitted and clean		
9	Generator filters fitted and checked		
10	Generator panic button and/or fusible link fitted		
11	Dump tank complete, clean and tested		
12	Dump tank hand pump and lockable valve installed		
13	All vent pipe clear and ballooned as appropriate		
14	Fill point complete and accessible		
15	Extinguisher in generator room		
16	Leak detection tape installed		
17	Leak detection tape operational		
18	Flush to waste with fuel from bulk tank to day tank		
19	Flush to waste with fuel from day tank to generator filters		
20	Fuel delivered		
21	Commission equipment as previously agreed method statement		

Comments

Checked/Tested by: ..... **Engineer** **For and on behalf of**	**Witnessed by:** ..... **Engineer** **For and on behalf of** .....

SECTION 02221 - BUILDING DEMOLITION

1.1 SUMMARY

A. Demolition and removal of buildings and site improvements.

1.2 QUALITY ASSURANCE

A. Quality Standard: ANSI A10.6 and NFPA 241.

1.3 PROJECT CONDITIONS

A. Hazardous Materials: Owner will arrange removal prior to start of the Work.

1.4 MATERIALS

A. Satisfactory Soils: Division 2 Section "Earthwork."

1.5 EXAMINATION

A. Perform an engineering survey of condition of buildings.

1.6 PREPARATION

A. Refrigerant: If any, remove according to 40 CFR 82.

B. Utility Shut Off: Owner.

1.7 DEMOLITION

A. Use of explosives is not permitted.

B. Salvage: Owner will salvage what they desire in advance of demolition

C. Below-Grade Construction: Demolish completely.

1. Remove completely to what ever depth is required.

D. Existing Utilities: Demolish completely back to point identified by SUU.

1.8 SITE RESTORATION

A. Below-Grade Areas: Fill per requirements of Earthwork Section

1.9 DISPOSAL OF DEMOLISHED MATERIAL

A. Remove demolished material from site and dispose of in an EPA-approved landfill.

END OF SECTION 02221

SECTION 02230 - SITE CLEARING

1.1 SUMMARY

A. Removing existing trees, plants and grass.

B. Clearing and grubbing obstructions, trees, shrubs, grass, and other vegetation including grinding stumps and removing roots and debris.

C. Stripping and stockpiling topsoil and stockpiling surplus topsoil.

D. Providing temporary erosion and sedimentation control measures.

END OF SECTION 02230

SECTION 02300 - EARTHWORK

1.1 SUMMARY

A. Preparing subgrades for slabs-on-grade walks pavements lawns and grasses exterior plants.

B. Excavating and backfilling or filling for buildings and structures, including footings and foundations .

C. Excavating and backfilling for utility trenches.

D. Excavation: Unclassified.

E. Grading.

F. Subsurface drainage backfill for walls and trenches.

G. Subbase course for concrete walks and pavements.

H. Subbase course for hot-mix asphalt pavement.

I. Drainage course for cast-in-place concrete slabs-on-grade.

1.2 MATERIALS

A. Soil Materials:

1. Satisfactory Soils: ASTM D 2487 soil classification groups.
2. Unsatisfactory Soils: ASTM D 2487 soil classification groups.
3. Backfill and Fill: Satisfactory soil materials.
4. Subbase Course: Natural or crushed gravel, crushed stone, and natural or crushed sand.
5. Engineered Fill: Natural or crushed gravel, crushed stone, and natural or crushed sand.
6. Bedding Course: Natural or crushed gravel, crushed stone, and natural or crushed sand.
7. Drainage Course: Crushed stone, or crushed or uncrushed gravel.
8. Filter Material: Natural or crushed gravel, or crushed stone and natural sand.
9. Sand: Natural or manufactured.
10. Impervious Fill: Clayey gravel and sand mixture.

B. Controlled low-strength material.

C. Warning Tape: Detectable polyethylene film.

1.3 EXCAVATION

A. Explosives: Not permitted.

B. Disposal of Surplus and Waste Materials: Off Owner's property.

1.4 FIELD QUALITY CONTROL

A. Geotechnical Testing Agency: Owner engaged.

END OF SECTION 02300

SECTION 02466 - DRILLED PIERS

1.1 SUMMARY

A. Drilled piers.

1.2 PROJECT CONDITIONS

A. Geotechnical report BY Gordon Spilker Huber Geotechnical Consultants, Inc. is available. Report is informational only- DFCM makes no guarantee as to the accuracy of this report. Contractors are encouraged to obtain their own investigation and report. Remember that boulders are not uncommon in the Cedar City area.

B. Contractor to engage a surveyor or engineer to perform surveys, layouts, and measurements for drilled piers.

1.3 MATERIALS

A. Steel Reinforcement: Deformed reinforcing bars.

B. Steel Casings: Steel or Corrugated-steel pipe (GSH report indicates that casings”casings should not be required in the drilling operation; however, it should be noted that occasional coarse gravels and cobbles will be penetrated”).

C. Concrete: 4000 psi.

1.4 INSTALLATION

A. Excavation: Unclassified.

B. Size: Minimum pier diameter is 2'.

C. Bottom Cleaning: It is essential that appropriate equipment be brought on site to effectively clean the bottom of the drilled piers.

1.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage inspector.

B. Testing Agency: Owner will engage agency.

END OF SECTION 02466

SECTION 02478 - HELICAL PIERS

1.1 MATERIALS

A. Galvanized round or square shaft helical piers.

1.2 PROJECT CONDITIONS

A. Geotechnical report BY Gordon Spilker Huber Geotechnical Consultants, Inc. is available. Report is informational only- DFCM makes no guarantee as to the accuracy of this report. Contractors are encouraged to obtain their own investigation and report. Remember that boulders are not uncommon in the Cedar City area.

B. Contractor to engage a surveyor or engineer to perform surveys, layouts, and measurements for helical piers.

1.3 INSTALLATION

A. Drive piers to depth required by geotechnical investigation.

B. Pier-driving records compiled by qualified professional engineer.

1.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage inspector.

B. Testing: By Owner-engaged agency.

END OF SECTION 02458

SECTION 02510 - WATER DISTRIBUTION

1.1 SUMMARY

A. Combined water service and fire-service mains outside the building.

1.2 SUBMITTALS

A. Coordination Drawings.

1.3 QUALITY ASSURANCE

A. Quality Standard for Electrical Components, Devices, and Accessories: NFPA 70.

B. Quality Standard for Materials, Installations, Tests, Flushing, and Valve and Hydrant Supervision for Fire-Service-Main Piping: NFPA 24.

C. Quality Standard for Plastic Potable-Water-Service Piping: NSF 14. Include marking "NSF-pw" on piping.

D. Quality Standard for Water-Service Piping and Specialties for Domestic Water: NSF 61.

E. Quality Standard for Fire-Service-Main Products: FMG's "Approval Guide."

1.4 MATERIALS

A. Underground Water-Service Piping NPS 3/4 to NPS 3:

1. Type K hard copper tube and copper solder-joint fittings.

B. Underground Combined Water-Service and Fire-Service-Main Piping:

1. Ductile-iron.

C. Piping Specialties:

1. Transition fittings.
2. Tubular-sleeve pipe couplings.
3. Split-sleeve pipe couplings.
4. Flexible connectors.
5. Dielectric fittings.

D. Corrosion-Protection Piping Encasement: Required.

1.5 MANUFACTURED UNITS

A. Gate Valves:

1. Cast Iron: OS&Y, rising stem, C509, 250 psig.
2. UL/FMG, Cast Iron: OS&Y, rising stem.
3. Bronze: UL/FMG, OS&Y, rising stem.

B. Check Valves: UL/FMG, 250 psig.

C. Butterfly Valves: UL/FMG.

D. Backflow Preventers:

1. Double-check, backflow-prevention assemblies.

END OF SECTION 02510

SECTION 02530 - SANITARY SEWERAGE

1.1 SUMMARY

A. Gravity-flow, nonpressure sanitary sewerage outside the building.

1.2 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.3 COMPONENTS

A. Cleanouts: PVC.

B. Manholes: Standard precast concrete.

1. Resilient pipe connectors.
2. Reinforced-concrete grade rings.
3. Manhole frames and covers.

1.4 INSTALLATION

A. Gravity-Flow, Nonpressure Sewer Piping Applications:

1. NPS 4: PVC sewer; or cast iron.
2. NPS 5 and NPS 6: PVC sewer; or cast iron.
3. NPS 8 and NPS 10: PVC sewer; or cast iron.

END OF SECTION 02530

SECTION 02630 - STORM DRAINAGE

1.1 SUMMARY

A. Gravity-flow, non-pressure storm drainage outside the building.

1.2 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.3 COMPONENTS

A. Cleanouts: PVC.in landscape; cast iron in paving.

B. Drains: Gray-iron area drains.

C. Manholes: Standard precast concrete.

1. Resilient pipe connectors.
2. Reinforced-concrete grade rings.
3. Manhole frames and covers.

D. Catch Basins: Standard precast concrete.

1. Frames and grates.

E. Stormwater Inlets: gutter type.

1.4 INSTALLATION

A. Gravity-Flow, Nonpressure Sewer Piping Applications:

1. NPS 4 to NPS 6: Corrugated PE drainage; ABS, SDR 35, sewer; PVC sewer; or Nonreinforced-concrete sewer pipe.
2. NPS 8 to NPS 12: Corrugated PE drainage; ABS, SDR 42, sewer Corrugated PE drainage PVC sewer Nonreinforced-concrete sewer pipe.
3. NPS 15: Corrugated PE drainage; PVC profile gravity sewer; or Nonreinforced-concrete sewer pipe.
4. NPS 18 to NPS 36: Corrugated PE drainage; PVC sewer; or Reinforced-concrete sewer pipe.

END OF SECTION 02630

SECTION 02741 - ASPHALT PAVING

1.1 SUMMARY

A. Hot-mix asphalt paving.

B. Pavement-marking paint.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: of UDOT Standard Specification for Road and Bridge Construction.

1.3 MATERIALS

A. Asphalt Materials:

1. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a.
2. Asphalt Cement: ASTM D 3381 for viscosity-graded material ASTM D 946 for penetration-graded material.
3. Prime Coat: Asphalt emulsion prime coat.
4. Tack Coat: Emulsified asphalt or cationic emulsified asphalt.

B. Auxiliary Materials:

1. Herbicide.
2. Pavement-Marking Paint: Alkyd-resin type.

C. Asphalt Mixes: Designed according to AI MS-2.

1. Base Course: ASTM D 3515, 1-inch maximum aggregate size.
2. Surface Course: ASTM D 3515, 1/2-inch maximum aggregate size.

1.4 INSTALLATION

A. Hot-Mix Asphalt Paving:

1. Proof-roll subgrade at locations receiving full-depth asphalt pavement.
2. Apply herbicide.
3. Apply prime coat over compacted unbound-aggregate base course.
4. Base Course: 12".
5. Surface Course: 5" for roadways, 4" for parking lots.

END OF SECTION 02741

SECTION 02751 - CEMENT CONCRETE PAVEMENT

1.1 SUMMARY

A. Curbs and gutters.

B. Walkways.

C. Roads/parking lots

1.2 QUALITY ASSURANCE

A. Quality Standard: ACI 301, "Specification for Structural Concrete."

1.3 MATERIALS

A. Reinforcement:

1. Reinforcing Bars and Tie Bars: Epoxy-coated deformed or Galvanized deformed steel.
2. Synthetic Fiber: Fibrillated at the rate of 1.5#/CY.
3. Welded wire mesh not allowed.

B. Concrete:

1. Portland Cement: ASTM C 150 withFly Ash: ASTM C 618, Class F; maximum 15% by weight
2. Aggregate: Normal-weight aggregate.
3. Admixture: Air entraining- 6.5% plus-or-minus 1.5%.
4. Compressive Strength: 4000 psi at 28 days.
5. Water/Cement Ratio: 0.45%.

C. Membrane-Forming Curing Compound: White waterborne.

D. Related Materials:

1. Expansion- and Isolation-Joint-Filler Strips: Cellulosic fiber.

1.4 FINISHING

A. Finishes: Medium-to-coarse-textured broom finish.

1.5 FIELD QUALITY CONTROL

A. Testing: By Owner-engaged agency.

END OF SECTION 02751

SECTION 02810 - IRRIGATION SYSTEMS

1.1 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with controller and automatic control valves.

B. Minimum Working Pressures:

1. Irrigation Main Piping: 200 psig.
2. Circuit Piping: 150 psig.

1.2 UNDERGROUND IRRIGATION MAIN PIPING

A. Pipe:

1. Schedule 40 Schedule 80, PVC pipe and Schedule 80 PVC or “Harco” ductile iron socket fittings, and solvent-cemented joints.

1.3 CIRCUIT PIPING

A. Pipe:

1. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; solvent-cemented joints.

1.4 DRAIN PIPING

A. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.

1.5 BRONZE BALL VALVES:

A. Apollo Ball Valves; Conbraco Industries, Inc.

B. Grinnell Corp.; Mueller Co.; Water Products Div.

1.6 BRONZE, AUTOMATIC CONTROL VALVES:

A. Rain Bird Sprinkler Mfg. Corp.

1.7 PLASTIC, AUTOMATIC CONTROL VALVES

A. Rain Bird Sprinkler Mfg. Corp.

1.8 CONTROL-VALVE BOXES:

A. AMETEK; Plymouth Products Div.

B. Carson-Brooks Plastics, Inc.

1.9 QUICK COUPLERS AND KEYS:

A. Rain Bird Sprinkler Mfg. Corp.

1.10 SPRINKLERS:

A. Rain Bird Sprinkler Mfg. Corp.

1.11 MISCELLANEOUS SPECIALTIES:

A. Rain Bird Sprinkler Mfg. Corp.

B. Netafim

1.12 CONTROLLERS:

A. Rain Bird Sprinkler Mfg. Corp.

B. Toro Co., Irrigation Div

1.13 BACKFLOW PREVENTER

A. Valve shall be tested to withstand pressures of 175 psi and meeting ASSE, CSA, IAPMO listed, SBCCI, USC approvals.

1.14 DRIP IRRIGATION SYSTEM

A. The valves to be used shall be Netafim 23N0B-041 Fast or 23N0B-05-04 Thread

1.15 DRIP SYSTEM PRESSURE REGULATION VALVE

A. The valve shall be a Toro Model Number PRV31-3/4HF45.

1.16 DRIP SYSTEM DISC FILTER

A. The filter shall be a Toro Model Number DF150-140 with a maximum flow of 20 GPM and a maximum pressure loss of 5 PSI.

1.17 DRIP SYSTEM AIR VACUUM / RELIEF VALVE

A. All Techline systems shall utilize Netafim Air Relief Valves

1.18 GATE VALVES

A. American Flow Control

1.19 PRESSURE REDUCING VALVE

A. Bermad Control Valves

B. CLA-VAL Co.

1.20 CAST - IRON FITTINGS

A. HARCO DEEP BELL; The Harrington Corporation of Lynchburg, VA.

1.21 CONTROL WIRING

A. UL 493, Type UF, solid-copper-conductor, insulated cable, suitable for direct burial.

1.22 DRAIN VALVES

A. NPS ½ and NPS 3/4: Bronze gate valve.

B. NPS 1 to NPS 2: Bronze gate valve.

1.23 MANUFACTURED UNITS

A. Automatic Control Valves: Bronze- by Orbit coordinate with DATC campus standard.

B. Pop-up, Impact-Drive Rotary Sprinklers: Plastic by Orbit- coordinate with DATC campus standard.

C. Surface, Pop-up Spray Sprinklers: Plastic- by Orbit with DATC campus standard..

D. Boxes for Automatic Control Valves: Plastic.

END OF SECTION 02810

SECTION 02920 - LAWNS AND GRASSES

1.1 SUMMARY

A. Sodded turf.

1.2 MAINTENANCE SERVICE

A. Turf: 90 days from date of Substantial Completion.

B. Mowing: Maintain to minimum height of 3".

C. Fertilizing: Three times at six week intervals at a rate of 5 pounds per 1000 square feet.

1.3 MATERIALS

A. Turfgrass Sod: Local mix with low water requirement.

B. Planting Soils: Existing, in-place surface soil, amended with inorganic and organic soil amendments and fertilizers in specified quantities.

C. Pesticides.

D. Fertilizer.

1.4 INSTALLATION

A. Planting Soil Depth for Newly Graded Subgrades: 4 inches.

B. Surface Soil Enrichment Depth for Unchanged Subgrades: 4 inches.

END OF SECTION 02920

SECTION 02930 - EXTERIOR PLANTS

1.1 WARRANTY

A. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.

B. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

C. Annuals: Three months.

1.2 MAINTENANCE SERVICE

A. Trees and Shrubs: Twelve months.

B. Ground Cover and Other Plants: Twelve months.

1.3 MATERIALS

A. Plants, General: Nursery-grown and complying with ANSI Z60.1.

B. Annuals and Biennials: Healthy and acclimated to outdoor conditions.

C. Planting Soils: Existing, in-place surface soil, amended with inorganic and organic soil amendments and fertilizers in specified quantities.

D. Lightweight On-Structure Planting Soil: Modified planting soil.

E. Mulches: Ground or shredded bark and crushed stone or gravel.

F. Weed-Control Barriers: Nonwoven fabric.

G. Herbicides: Registered and approved by EPA pre-emergent and post-emergent herbicide(s).

H. Fertilizer: Commercial, O-F-241C, type 1, grade 16-16-8, Level B

I. Tree Stabilization: Upright staking and tying.

J. Landscape Edgings: Concrete.

K. Root barrier.

1.4 INSTALLATION

A. Planting Soil Depth: 6 inches.

B. Mechanized tree spade planting of designated trees.

C. Pruning.

D. Ground Cover and Plant Planting: Space ground cover and plants other than trees, shrubs, and vines 24 inches apart in even rows with triangular spacing.

E. Mulching:

1. Trees and Tree-like Shrubs in Turf Areas: Organic mulch ring of 3-inch thickness with 12-inch-24-inch radius.
2. Planting Areas: 3-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area.

END OF SECTION 02930

Section 03300 - CAST-IN-PLACE CONCRETE

1.1 SUMMARY

A. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Suspended slabs.

1.2 QUALITY ASSURANCE

A. Quality Standard: ACI 301.

B. Mockups to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

1.3 MATERIALS

A. Form-facing materials.

B. Steel Reinforcement:

1. Reinforcing Bars: Deformed Steel bar mats.

C. Concrete Materials:

1. Portland Cement: ASTM C 150, Type I/II, gray, supplemented with no more than 15% fly ash.
2. Aggregate: Normal weight and light weight
3. Water.
4. Admixtures: High range, water reducing.

D. Curing Materials: Clear, waterborne, membrane-forming curing, dissipating compound.

E. Sealer: Seal floors to be left exposed.

F. Related Materials: Expansion- and isolation-joint-filler strips.

1.4 CONCRETE MIXTURES

A. Compressive Strength (28 Days):

1. Footings: 3000 psi.
2. Foundation Walls: 3500 psi.
3. Slabs-on-Grade: 4000 psi.

4. Suspended Slabs 4000 psi

B. Mixing: Ready mixed.

1.5 INSTALLATION

A. Formed-Surface Finish: Smooth.

B. Floor and Slab Finishes:

1. Scratch: Surfaces to receive mortar setting beds for bonded cementitious floor finishes.
2. Trowel: Surfaces exposed to view, and surfaces to be covered with resilient flooring carpet ceramic or quarry tile set over a cleavage membrane thin film-finish coating system.

1.6 FIELD QUALITY CONTROL

A. Testing: By Owner-engaged agency.

B. Inspections: By Owner-engaged special inspector.

END OF SECTION 03300

SECTION 03450 - ARCHITECTURAL PRECAST CONCRETE

1.1 SUMMARY

A. Architectural precast concrete trim units (sills, lintels, trim).

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Fabricator to design architectural precast concrete units.

1.3 QUALITY ASSURANCE

A. Installer: PCI-certified erector.

B. Fabricator: PCI-certified plant.

C. Design Standards: ACI 318 and PCI MNL 120.

D. Quality-Control Standard: PCI MNL 117.

E. Sample panels for each finish, color, and texture variation.

F. Mockups.

G. Preconstruction testing mockup.

1.4 MATERIALS

A. Reinforcing Materials:

1. Reinforcing Bars: Epoxy-coated steel

B. Concrete Materials:

1. Portland Cement: ASTM C 150, Type I or Type III.
2. Supplementary Cementitious Materials: Fly ash.
3. Aggregates: Normal weight.
4. Coloring admixture: Mineral based.
5. Admixtures: Air entraining and water reducing,

C. Steel Connections High-strength bolts and nuts.

1. Finish: Galvanized.

D. Grout: Nonmetallic, nonshrink.

E. Latex-portland cement pointing grout for thin brick unit joints.

F. Stone facing specified in Division 4 with stainless-steel anchors.

1.5 CONCRETE MIXTURES

A. Compressive Strength (28 Days):

1. Normal-Weight Concrete Face and Backup Mixtures: 5000 psi.
2. Lightweight Concrete Backup Mixtures: 5000 psi.

1.6 FABRICATION

A. Finishes: As designed.

1.7 FIELD QUALITY CONTROL

A. Special Inspections: By Owner-engaged agency.

B. Testing and Inspections: By Owner-engaged agency.

END OF SECTION 03450

SECTION 04810 - UNIT MASONRY ASSEMBLIES

1.1 SUMMARY

A. Masonry Construction:

1. Single-wythe masonry.
2. Cavity walls.
3. Masonry veneer.
4. Installation of pre-cast trim.

1.2 PERFORMANCE REQUIREMENTS

A. Net-Area Compressive Strengths (f'_m) of Structural Unit Masonry: As indicated.

B. Determine net-area compressive strength (f'_m) of masonry by testing masonry prisms.

1.3 QUALITY ASSURANCE

A. Preconstruction Testing Service: Owner engaged, with payment by Owner.

B. 48" long by 48" high mockups of typical wall system.

1.4 MATERIALS

A. Concrete Masonry Units (CMUs):

1. Units made with integral water repellent for exposed units.
2. Concrete Masonry Units: Lightweight. 8" x 8" x 16"; 8" x 10" x 16" modular

B. Sills, Lintels and trim pieces: precast concrete.

C. Brick: Face brick. 2 1/4" H x 7 5/8" L x 3 5/8" D ASTM C-216; FBS; FBX; SW modular brick.

D. Reinforcing Steel: Uncoated steel bars.

E. Masonry Joint Reinforcement:

1. Interior Walls: Mill carbon steel.
2. Exterior Walls: Hot-dip galvanized steel.

F. Ties and Anchors: Hot-dip Galvanized steel.

1. Adjustable Masonry-Veneer Anchors: Seismic (ties to engage horiz. joint reinforcement.

G. Embedded Flashing:

1. Concealed (Flexible) Flashing: asphalt/fabric-coated copper.

   a. Used with flashing terminations.

2. Exposed Flashing: Stainless Steel- dull mill finish, 24 GA. Extend per Utah IBC ammendment.

H. Weep/Vent Holes: Open head joints.

I. Cavity drainage material: “Mortar Net”, or equal

J. Reinforcing bar positioners.

K. Cavity-Wall Insulation: Extruded-polystyrene board.

L. Mortar.

1. Masonry cement and mortar cement not allowed.
2. Integral water repellent by same manufacturer as CMU water repellent for CMU exposed to weather.

1.5 SOURCE QUALITY CONTROL

A. Testing Agency: Owner engaged, with payment by Owner.

1.6 INSTALLATION

A. Bond Pattern: As designed- running bond recommended.

B. Joints to be concave tooled. With Owner’s permission, weather raked joints will be considered.

1.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged, with payment by Owner.

END OF SECTION 04810

SECTION 05120 - STRUCTURAL STEEL

1.1 SUMMARY

A. Structural-steel framing.

1.2 QUALITY ASSURANCE

A. Fabricator Qualifications: AISC-Certified Plant.

B. Quality Standard: AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

1.3 MATERIALS

A. Structural-Steel Shapes: Tube and W shapes.

B. Bolts, Nuts, and Washers: High strength.

C. Connectors: Shear connectors.

D. Primer: Fabricator's standard, nonasphaltic.

E. Grout: Nonmetallic, shrinkage resistant.

1.4 FABRICATION

A. Shop Connections: high-strength bolts and welded connections.

B. Surface Preparation: SSPC-SP 2.

C. Galvanizing: Hot dip for ferrous metal exposed to weather .

1.5 SOURCE QUALITY CONTROL

A. Testing Agency: Owner engaged.

1.6 INSTALLATION

A. Field Connections: high-strength bolts and welded connections.

1.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged.

END OF SECTION 05120

SECTION 05210 - STEEL JOISTS

1.1 SUMMARY

A. Open-web K-series steel joists for roof framing.

B. KCS-type, open-web K-series steel joists for roof framing.

C. Joist girders for roof framing.

D. Joist accessories, including permanent bridging.

1.2 MATERIALS

A. Bolts: High-strength carbon steel.

1. Finish: Plain, uncoated.

B. Primer: SSPC-Paint 15.

C. Open-Web K-Series Steel Joists.

D. Joist Girders:

1. End Arrangement: Underslung.
2. Top-Chord Arrangement: Parallel.

1.3 INSTALLATION

A. Connections: Welded.

1.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage testing agency to inspect field welds and bolted connections.

END OF SECTION 05210

05310 - STEEL DECK

1.1 SUMMARY

A. Roof deck.

B. Composite floor deck.

1.2 QUALITY ASSURANCE

A. FMG Listing: Steel roof deck.

1.3 MATERIALS

A. Roof Deck: Galvanized steel sheet.

1. Profile Depth: As determined by structural design.
2. Gauge: As determined by structural design.
3. Galvanizing: G90 coating.

B. Composite Floor Deck: Galvanized steel sheet.

1. Profile Depth: As determined by structural design.
2. Gauge: As determined by structural design.
3. Galvanizing: G60 coating.

C. Accessories: Flexible closure strips, pour stops, girder fillers, column closures, end closures, Z-closures, and cover plates, recessed sump pans and flat sump plates.

1.4 INSTALLATION

A. Roof Deck: Welded.

B. Floor Deck: Welded.

1.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner engaged.

END OF SECTION 05310

SECTION 05500 - METAL FABRICATIONS

1.1 SUMMARY

A. Miscellaneous metal framing and supports.

B. Loose metal plates and shapes.

C. Miscellaneous fabricated metal items.

1.2 PRODUCTS

A. Materials: Steel plates, shapes, and bars Steel tubing Steel pipe Slotted channel framing.

B. Miscellaneous Framing and Supports:

1. Steel framing and supports for overhead doors countertops applications where framing and supports are not specified in other Sections.
2. Galvanize at exterior locations.
3. Prime with zinc-rich primer where indicated.

C. Loose bearing and leveling plates , primed with zinc-rich primer.

D. Miscellaneous Steel Trim: .

1. Galvanize exterior locations.
2. Prime interior locations with zinc-rich primer.

E. Metal Ladders: Steel.

1. Prime interior locations with zinc-rich primer.

F. Metal Bollards: Schedule 40 steel pipe- galvanized.

END OF SECTION 05500

SECTION 06105 - MISCELLANEOUS CARPENTRY

1.1 SUMMARY

A. Sheathing for nailing asphalt shingles.

B. Wood blocking and nailers.

C. Plywood backing panels.

1.2 MATERIALS

A. Wood-Preservative-Treated Materials:

1. Preservative Treatment: AWPA C2 with chemicals containing no arsenic or chromium.

   a. AWPA C31 (inorganic boron) may be used in protected locations.

2. Application: Items indicated and the following:

   a. Items in contact with roofing or waterproofing.
   b. Items in contact with concrete or masonry.
   c. Framing less than 18 inches above ground in crawlspaces.

B. Fire-Retardant-Treated Materials:

1. Application: Items indicated and the following:

   a. Concealed blocking.
   b. Plywood backing panels.

C. Dimension Lumber Framing:

1. Maximum Moisture Content: 19 percent.
2. Other Framing: Construction or No. 2 grade hem-fir.

D. Plywood backing panels for telephone and electrical equipment.

E. Fasteners: Hot-dip galvanized steel where exposed to weather, in ground contact, in contact with treated wood, or in area of high relative humidity.

F. Metal Framing Anchors:

1. Metal: Hot-dip galvanized steel.

END OF SECTION 06105

SECTION 06402 - INTERIOR ARCHITECTURAL WOODWORK

1.1 SUMMARY

A. Interior standing and running trim.

B. Wood and plastic-laminate cabinets.

C. Solid-surfacing-material countertops.

D. Closet and utility shelving.

1.2 QUALITY ASSURANCE

A. Quality Standard: AWI.

1.3 MATERIALS

A. Wood Species and Cut for Transparent Finish: Red oak, plain sawn or sliced.

B. Composite Wood Products: Made without urea formaldehyde.

C. Cabinet Hardware:

1. Hinges: Frameless, concealed.
2. Pulls: Back mounted Wire.
3. Exposed Hardware Finishes: Satin chromium plated.

D. Interior Woodwork Grade: Custom.

E. Interior Standing and Running Trim for Transparent Finish:

1. Grade: Custom.
2. Wood Species and Cut: Red oak, plain sawn.

F. Wood Cabinets for Transparent Finish:

1. Grade: Custom.
2. AWI Type of Cabinet Construction: Flush overlay.
3. Wood Species and Cut for Exposed Surfaces: Red oak, plain sawn or cut.
4. Cabinet Interior: Thermoset decorative panels.

G. Plastic-Laminate Cabinets:

1. Grade: Custom.
2. AWI Type of Cabinet Construction: Flush overlay.

3. Cabinet Interior: Thermoset decorative panels.

H. Solid-Surfacing-Material Countertops:

1. Grade: Custom.
2. Thickness: ½ inch.

I. Closet and Utility Shelving: Custom grade.

J. Shop Finishing:

1. Grade: Same grade as woodwork.
2. Extent: All woodwork shop finished.

END OF SECTION 06402

SECTION 07210 - BUILDING INSULATION

1.1 SUMMARY

A. Applications:

1. Perimeter insulation under slabs-on-grade.
2. Cavity-wall insulation.
3. Concealed building insulation.
4. Exposed building insulation.
5. Vapor retarders.
6. Sound attenuation insulation.
7. Under Slab vapor retarder.
8. Air infiltration barrier.

1.2 PERFORMANCE REQUIREMENTS

A. Plenum Rating: Glass-fiber insulation rated for resistance against erosion and mold growth per UL 181.

1.3 MATERIALS

A. Insulation:

1. Extruded-Polystyrene Board: Type X, 1.30 lb/cu. ft.
2. Foil-Faced Polyisocyanurate Board: Type I, Class 1 or 2..
3. Unfaced Glass-Fiber Blanket: Type I.
4. Cellulosic-Fiber Loose Fill: Chemically treated for flame resistance.

B. Vapor Retarders: FSK-25, Foil-scrim-kraft w/flame spread of 25 or less- tape all joints.

C. Under slab vapor retarders: Reinforced LDPE membrane- tape all joints

D. Air infiltration barrier: Comply with IBC standard 14-1, “Tyvek” or equal, tape all joints.

E. Auxiliary Insulating Materials:

1. Insulation fasteners.

END OF SECTION 07210

SECTION 07311 - ASPHALT SHINGLES

1.1 SUMMARY

A. Asphalt shingles.

B. Underlayment.

1.2 QUALITY ASSURANCE

A. Exterior Fire-Test Exposure: Class A; ASTM E 108 or UL 790.

B. Mockup of each form of construction.

1.3 WARRANTY

A. Material Warranty Period: 50 years (remember this requires ventilation space under the sheathing.

B. Workmanship Warranty Period: 10 years.

C. Roofing Installer's Warranty: Two years.

1.4 PRODUCTS

A. Glass-Fiber-Reinforced Asphalt Shingles: Double fiberglass mat constructed with a random cut sawtooth design. The two layers of mat are coated with asphalt and then laminated together and surfaced with mineral granules. A self sealing strip of asphalt is provided for added wind resistance. 12" wide x 36" long, with a 5" exposure type.

1. Hip and Ridge Shingles: Standard units.

B. Underlayment: Felt(s) and Self-adhering sheet underlayment, polyethylene faced.

C. Ridge Vents: Rigid, high-density plastic.

D. Metal Flashing and Trim: Color-Clad galvanized sheet metal for step flashing, Pre-finished aluminum for drip edges, and Oatey rebber seal pipe jack flashing.

1. Types: Step flashings cricket flashings drip edges and vent pipe flashings.

1.5 INSTALLATION

A. Underlayment: Single-layer felt(s).

B. Ice-Dam Membrane: Self-adhering sheet- “Ice and Water Shield- extend 30" above inside face of perimeter walls, and 30" either side of all valleys and ridges.

C. Installation Standard: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and asphalt shingle recommendations in NRCA's "The NRCA Roofing and Waterproofing Manual."

D. Valleys: Match Phase 1.

END OF SECTION 07311

SECTION 07620 - SHEET METAL FLASHING AND TRIM

1.1 SUMMARY

A. Formed Low-Slope Roof Flashing and Trim and Soffit:

1. Copings.
2. Gable end trim
3. Soffits

1.2 PERFORMANCE REQUIREMENTS

A. Copings: Capable of resisting Wind Zone 2 forces according to FMG Loss Prevention Data Sheet 1-49.

1.3 QUALITY ASSURANCE

A. Quality Standard: SMACNA's "Architectural Sheet Metal Manual."

1.4 MATERIALS

A. Sheet Metals for Flashing and Trim:

1. Prepainted, Metallic-Coated Steel or Aluminum: High-performance organic.

B. Underlayment: Polyethylene sheet.

END OF SECTION 07620

SECTION 07841 - THROUGH-PENETRATION FIRESTOP SYSTEMS

1.1 SUMMARY

A. Through-penetration firestop systems for penetrations through fire-resistance-rated fire walls fire partitions fire barriers smoke barriers floors floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.

1.2 PERFORMANCE REQUIREMENTS

A. Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:

1. F-Rated Systems: F-ratings equaling or exceeding fire-resistance rating of constructions penetrated.
2. T-Rated Systems: For penetrations located outside wall cavities and outside fire-resistance-rated shaft enclosures.
3. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A firm approved by FMG according to FMG 4991, "Approval of Firestop Contractors."

B. Fire-Test-Response Characteristics: Tested per ASTM E 814 by UL.

1.4 MATERIALS

A. Accessories: Permanent forming/damming/backing materials substrate primers collars and steel sleeves as needed to comply with performance requirements.

1.5 INSTALLATION

A. Identification: Preprinted metal or plastic labels, permanently attached.

1.6 FIELD QUALITY CONTROL

A. Inspection of Installed Firestop Systems: By Owner-engaged agency according to ASTM E 2174 requirements.

END OF SECTION 07841

SECTION 07920 - JOINT SEALANTS

1.1 SUMMARY

A. Exterior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces:

1. Control and expansion joints in unit masonry.
2. Joints between different materials listed above.
3. Perimeter joints around frames of doors windows.

B. Exterior Joints in Horizontal Traffic Surfaces:

1. Isolation and contraction joints in cast-in-place concrete slabs.
2. Joints between different materials listed above.

C. Interior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces:

1. Control and expansion joints on exposed interior surfaces of exterior walls.
2. Perimeter joints of exterior openings.
3. Control and expansion and inside corner joints in tile.
4. Vertical joints on exposed surfaces of interior unit masonry walls.
5. Perimeter joints between interior wall surfaces and frames of interior doors windows.
6. Joints between plumbing fixtures and adjoining walls, floors, and counters.

D. Interior Joints in Horizontal Traffic Surfaces:

1. Isolation joints in cast-in-place concrete slabs.

1.2 WARRANTY

A. Installer: Two years.

B. Manufacturer: Ten years.

1.3 MATERIALS

A. Elastomeric Joint Sealants: Liquid applied, chemically curing; ASTM C 920.

1. Pourable neutral-curing silicone sealants.
2. Nonsag neutral-curing silicone sealants.
3. Acid-curing silicone sealants.
4. Mildew-resistant neutral-curing silicone sealants.
5. Nonsag and Pourable urethane sealants.

B. Latex Joint Sealants: ASTM C 834, Type P, Grade NF.

C. Acoustical Joint Sealants: Latex.

D. Preformed Tape Sealants: Back-bedding mastic, butyl based.

E. Joint-Sealant Backing: Cylindrical Closed Cell Elastomeric tubing.

END OF SECTION 07920

SECTION 08110 - STEEL DOORS AND FRAMES

1.1 SUMMARY

A. Standard hollow metal doors and frames.

1.2 QUALITY ASSURANCE

A. Standard Hollow Metal Quality Standard: ANSI/SDI A250.8.

1.3 PRODUCTS

A. Standard Hollow Metal Doors:

1. Design: Flush panel.
2. Thermal-Rated Doors: Exterior.
3. Exterior Doors: 16 ga. Galvanized steel sheet faces.

a. Model: 1 (Full Flush)
b. Tob of Door: Provide closed top design sealed against water intrusion.

4. Interior Doors: 18 ga. cold-rolled steel sheet faces.

a. Model: 1 (Full Flush).

B. Standard Hollow Metal Frames:

1. Exterior Frames: Galvanized steel sheet; face welded.

a. 14 ga thick steel sheet.
b. Rigid insulation

2. Interior Frames: Cold-rolled steel sheet; face welded.

a. 16 ga thick steel sheet up to 4 foot opening, 14 ga. over 4 foot.

C. Finishes: Factory priming for field painting.

1.4 INSTALLATION

A. Concrete and Masonry Walls: Frames filled with grout.

END OF SECTION 08110

SECTION
08211 - FLUSH WOOD DOORS

1.1
QUALITY ASSURANCE

A. Quality Standard: AWI.

1. AWI Quality Certification Labels or an AWI letter of licensing for doors.

B. Fire-Rated Wood Doors: Comply with IBC for pressure testing.

1.2 DOOR CONSTRUCTION, GENERAL

A. Low-Emitting Materials: Made with adhesives and composite wood products that do not contain urea formaldehyde.

1.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Exterior Solid-Core Doors Not acceptable

B. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces .
2. Species: Red oak.
3. Cut: Plain sliced (flat sliced), Quarter sliced, or Rift cut. Rotary cut is unacceptable.
4. Match between Veneer Leaves: Book; Slip or Pleasing match.
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Edge: Matching veneer
7. Special Matching:

a. Pair and set match.
b. Room Match: Door faces of compatible color and grain within each room.

8. Core: Particleboard.
9. Construction: Five or seven plies, bonded.

C. Interior Hollow-Core Doors Not acceptable:

1.4 LOUVERS AND LIGHT FRAMES

A. Louvers: Not acceptable.

B. Light-Opening Frames:

1. Metal.

1.5 PRIMING/FINISHING

A. Factory Finishing: All doors.

B. Transparent Factory Finishes:

1. Grade: Premium.
2. Finish: Catalyzed polyurethane.
3. Effect: Semifilled finish.

END OF SECTION 08211

SECTION 08311 - ACCESS DOORS AND FRAMES

1.1 SUMMARY

A. Access doors and frames for walls and ceilings.

B. Floor access doors and frames.

1.2 QUALITY ASSURANCE

A. Fire-Rated Vertical Access Doors and Frames: NFPA 252 or UL 10B.

B. Fire-Rated Horizontal Access Doors and Frames: ASTM E 119 or UL 263.

1.3 PRODUCTS

A. Access Doors and Frames for Walls and Ceilings:

1. Type:

   a. Flush access doors and frames with exposed trim.
   b. Fire-rated, insulated, flush access doors and frames with exposed trim.

2. Material: Steel (except in restroom wall installations); Stainless steel (in restrooms if mounted in tile).
3. Fire-Resistance Rating: As required to match wall or ceiling rating..
4. Latch: Self-latching bolt operated by screwdriver with interior release.

B. Finishes:

1. Steel: Primed finish.
2. Stainless Steel: Directional satin, No. 4 finish.

END OF SECTION 08311

SECTION 08411 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

1.1 SUMMARY

A. Exterior storefront framing.

B. Exterior manual-swing entrance doors and door-frame units.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance:

1. Wind Loads: 20 psf.

1.3 MAINTENANCE SERVICE

A. Entrance Door Hardware: Twelve months.

1.4 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer.

B. Steel reinforcement.

1.5 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members.

1. Construction: Thermally broken.
2. Glazing System: Retained mechanically with gaskets on four sides.

B. Brackets and reinforcements.

C. Fasteners and accessories.

D. Concrete and masonry inserts.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing

F. Framing system gaskets and sealants.

1.6 GLAZING SYSTEMS

A. Glazing: As specified in Division 8 Section "Glazing."

B. Glazing gaskets.

C. Spacers and setting blocks.

D. Bond-breaker tape.

E. Glazing Sealants:

1. Weatherseal sealant.

1.7 ENTRANCE DOOR SYSTEMS

A. Entrance Doors:

1. Door Construction: 1-3/4-inch overall thickness.
2. Door Design: medium stile rails with 10" bottom rail and 5" top rail.
3. Glazing stops and gaskets.

B. Entrance Door Hardware:

1. Hinges: continuous heavy Duty gear hinges- Roton or equal.
2. Exit device: SUU prefers Von Duprin.
3. Closer: SUU prefers LCN- provide closer with hold open function, and “cush-n-stop” function.
4. Provide electric operator at main entry to comply with DFCM enhanced accessibility.
5. Stainless steel kick plate

1.8 ALUMINUM FINISHES

A. Aluminum Finishes: Class II, clear or color anodic.

1.9 SOURCE QUALITY CONTROL

A. Structural-Sealant-Glazed Systems: Tested and inspected according to ASTM C 1401 recommendations.

END OF SECTION 08411

SECTION 08520 - ALUMINUM WINDOWS

1.1 PERFORMANCE REQUIREMENTS

A. Engineering design of aluminum windows by Contractor.

B. Basic Wind Speed: 90 mph.

1.2 QUALITY ASSURANCE

A. Quality Standard: AAMA/WDMA 101/I.S.2/NAFS.

1.3 WINDOWS

A. Type: Fixed- thermal break construction

B. Sub Sill: Provide aluminum sub sill with vertical legs turned up at the back and ends and with all joints sealed to shed water to the outside of the building.

C. U-Factor: 0.43 Btu/sq. ft. x h x deg F or less.

D. Solar Heat-Gain Coefficient: Whole-window SHGC maximum of 0.50.

E. Glazing: Site glazed.

1. Glass: See Glazing Section.
2. Glazing System: Manufacturer's standard.

F. Finishes: Class II, clear or color anodic- Dark Bronze.

END OF SECTION 08520

SECTION 08561 - VINYL WINDOWS

1.1 PERFORMANCE REQUIREMENTS

A. Engineering design of vinyl windows by Contractor.

B. Basic Wind Speed: 90 mph.

1.2 QUALITY ASSURANCE

A. Quality Standard: AAMA/WDMA 101/I.S.2/NAFS.

B. Mockups for each form of construction.

1.3 WARRANTY

A. Windows: 10 years.

B. Glazing: 10 years.

C. Vinyl Finish: Five years.

1.4 WINDOWS

A. Type: Single hung.

B. Condensation-Resistance Factor: 52.

C. U-Factor: 0.43 Btu/sq. ft. x h x deg F or less..

D. Sound Transmission Class: 35.

E. Glazing: See Glazing section for requirements.

F. Hardware: Manufacturer’s standard non-corrosive hardware.

G. Insect Screens: Tubular aluminum frame with [manufacturer's standard finish.

1. Screen: Glass-fiber-mesh fabric.

H. Vinyl Finishes: Integral.

END OF SECTION 08561

SECTION 08710 - DOOR HARDWARE

1.1 SUMMARY

A. Commercial door hardware for swinging doors.

1.2 MAINTENANCE SERVICE

A. Full-Maintenance Service: Twelve months.

1.3 PRODUCTS

A. Hinges:

1. Aluminum Doors: Gear type extruded aluminum heavy duty anodize to match window system
2. Interior: Brass or Steel, exposed ball bearing type
3. Fire-Rated Assemblies: Steel or stainless steel, exposed ball bearing type
4. Options: maximum security pin on outswinging exterior doors and nonremovable pins on outswinging corridor doors.

B. Mechanical Locks and Latches: Best, Sargent, Schlage, or Yale.

1. Cylindrical Lockset Design: heavy duty lever locks equal to Schlage “D” series with option that allows lever to turn when locked (like Schlage “Vandelgard at exterior doors).

C. Auxiliary Locks and Latches: Grade 1.

D. Self-contained electronic locks: Internal, battery-powered, self-contained electronic locks; consisting of complete lockset, motor-driven lock mechanism, and actuating device; enclosed in zinc-dichromate-plated, wrought-steel case. Provide key override, low-battery detection and warning, LED status indicators, and ability to program at the lock; type and function indicated.

1. Type: Bored.
2. Actuating Device: Magnetic-stripe card reader.

a. Card: Manufacturer's standard 0.030-inch- thick PVC or polyester.

3. Faceplate Material: Stainless steel.
4. Trim: Match trim specified for mechanical locks.

E. Accessory: Card encoder and software.

F. Manufacturers:

1. Best Access Systems; Div. of The Stanley Works (BAS).

2. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
3. Schlage Commercial Lock Division; an Ingersoll-Rand Company (SCH).
4. Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).

G. Door Bolts:

1. Dustproof Strikes: Grade 1.

H. Exit Devices: Von Duprin.

1. Panic exit devices.
2. Fire exit devices.
3. Outside Trim: Match locksets and latchsets.

I. Cylinders and Keying:

1. Cylinders: **Medeco** interchangable cylinders keyed to existing system- Contractor to coordinate with SUU.

   a. Grade 1.
   b. Number of Pins: Seven.
   c. Cores: Interchangeable.

2. Construction Keying: Construction cores.
3. Keying System:

   a. Great-grand master key.
   b. Locks master keyed or grand master keyed to existing system.
   c. All cylinders keyed alike.
   d. Keys: Nickel silver.

J. Key-Control System:

1. Cabinet: Grade 1, wall mounted.
2. Index System: Multiple index, computer software.

K. Key lock boxes.

L. Operating Trim: Stainless steel.

M. Closers: LCN

1. Surface: Grade 1.
2. Closer holder release devices.
3. Coordinators- rectangular units mounted at frame head- full width of opening Glynn Johnson COR or similar.

N. Protective Trim Units: Stainless steel.

O. Stops at all doors.

P. Silencers for metal door frames w/o smoke seals.

Q. Door Gasketing: As required for rating and acoustics.

R. Finishes: US 26D, (except for kick plates, mop plates, armor plates, push and pull which will all be 32D).

1.4 FIELD QUALITY CONTROL

A. Occupancy Adjustment: Twelve months.

END OF SECTION 08710

SECTION 08800 - GLAZING

1.1 SUMMARY

A. Glazing required for the following:

1. Windows.
2. Doors.
3. Glazed entrances.
4. Interior borrowed lites.
5. Storefront framing.

1.2 WARRANTY

A. Deterioration of Coated Glass: Not less than 10 years.

B. Deterioration of Insulating Glass: Not less than 10 years.

1.3 MATERIALS

A. Glass Products:

1. Annealed Float Glass: Clear and Tinted.
2. Heat-Treated Float Glass: fully tempered.
3. Coated Float Glass: Pyrolytically or Sputter coated.
4. Wired Glass: Square pattern.
5. Insulating Glass: Manufacturer's standard dual-seal units.

B. Silicone Glazing Sealants: Neutral or basic curing, Class 25.

C. Glazing Tapes: Back-bedding-mastic type.

D. Glazing Gaskets: Dense compression.

1.4 GLASS UNITS

A. Monolithic Float-Glass Units:

1. 6 mm clear

B. Insulating-Glass Units:

1. Tinted outer 6 mm lite, ½" air space, 6mm clear inner lite with low E coating on 3rd surface.

END OF SECTION 08800

SECTION 09111 - NON-LOAD-BEARING STEEL FRAMING

1.1 SUMMARY

A. Non-load-bearing steel framing members for interior framing and suspension systems.

1.2 MATERIALS

A. Suspension Systems:

1. Wire hangers.
2. Flat hangers.
3. Carrying channels.
4. Furring channels.
5. Grid suspension systems for ceilings.

B. Steel Framing for Framed Assemblies:

1. Interior studs and runners: minimum 3 5/8" x 20 ga. Space studs at 16" O.C.
2. Exterior studs- gauge and depth as required for wind and seismic loads- however space studs at 24" O.C. to reduce insulation derating because of thermal bridging.
3. Studs at door jambs: 16 ga. studs to structure or cross bracing.
4. Slip-Type Head Joints:

    a. Single long-leg runner.
    b. Double runner.
    c. Deflection track.

5. Firestop track.
6. Flat strap and backing plate.
7. Cold-rolled channel bridging.
8. Hat-shaped, rigid furring channels.
9. Resilient furring channels.
10. Cold-rolled furring channels.
11. Z-shaped furring.

END OF SECTION 09111

SECTION 09250 - GYPSUM BOARD

1.1 SUMMARY

A. Interior gypsum board.

1.2 MATERIALS

A. Interior Gypsum Board: Minimum 5/8" thick.

1. Regular type.
2. Type X.
3. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
4. Moisture- and mold-resistant type.
5. Abuse resistant panels, USG Fiberock or equal, VHI (very high impact) for all walls in community type areas and hallways.

B. Trim Accessories:

1. Metal only- no plastic. Provide muddable types only, where exposed to view- no “J” mold is acceptable in exposed areas.

1.3 INSTALLATION

A. Install gypsum board vertically unless the space is too high for single panels.

B. In areas with oblique lighting- i.e. corridors with a window at the end, lobby walls that end at windows, etc., provide level 5 finish.

C. All exposed areas, except those above, provide a level 4 finish.

D. Knockdown texture may be acceptable on ceilings, verify with SUU. Walls to have no texture.

END OF SECTION 09250

SECTION 09310 - CERAMIC TILE

1.1 SUMMARY

A. Ceramic mosaic, paver, glazed wall and special-purpose tile.

B. Stone thresholds installed as part of tile installations.

C. Crack-suppression membrane for thin-set tile installations.

D. Metal edge strips installed as part of tile installations.

1.2 MATERIALS

A. Glazed Wall Tile Trim Shapes: Coved base Straight base Surface bullnose cap Bullnose external corner.

B. Ceramic Mosaic Trim Shapes: Coved base.

C. Thresholds: Marble w/ double bevel.

D. Crack-Suppression Membranes: Chlorinated polyethylene sheet PVC sheet Polyethylene sheet Corrugated polyethylene Fabric-reinforced, modified-bituminous sheet Fabric-reinforced, fluid-applied rubber Urethane waterproofing and tile-setting adhesive.

E. Elastomeric Sealants: One-part, mildew-resistant silicone.

1.3 FLOOR TILE INSTALLATION SCHEDULE

A. Interior Floors on Crack-Suppression/Waterproof Membrane over Concrete: Thin-set mortar over setting bed. Provide 1 ½" recess in slab for setting bed.

1. Tile Type: 2" x2" unglazed ceramic mosaic tile- color groups 1 & 2.
2. Mortar: Latex- portland cement mortar bond coat.
3. Grout: Polymer-modified sanded grout- seal joints with “Aquamix” penetrating sealer.

1.4 WALL TILE INSTALLATION SCHEDULE

A. Interior Walls over Gypsum Board on Metal Studs: Organic adhesive.

1. Tile Type: Glazed wall tile- in restrooms, all wall shall be tile floor to ceiling.
2. Grout: Polymer-modified unsanded grout.

END OF SECTION 09310

SECTION 09511 - ACOUSTICAL PANEL CEILINGS

1.1 SUMMARY

A. Acoustical panels and exposed suspension systems.

1.2 QUALITY ASSURANCE

A. Acoustical Panel Quality Standard: ASTM E 1264.

B. Metal Suspension System Quality Standard: ASTM C 635.

1.3 MATERIALS

A. Acoustical Ceiling Panels:

1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
2. Pattern: E (lightly textured) or G (smooth).
3. LR: Not less than 0.90.
4. NRC: Not less than 0.70.
5. CAC: Not less than 25.
6. Thickness: 3/4 inch.
7. Modular Size: 24 by 24 inches with reveal (tegular) edge.

B. Metal Suspension Systems:

1. Wire hangers, braces, and ties.
2. Hanger rods.
3. Angle hangers.
4. Seismic perimeter stabilizer bars, struts, and clips.
5. Wide-Face, Capped, Double-Web Steel: Intermediate duty.

C. Metal Edge Moldings and Trim: “Step” also known as “shadow” type edge molding (see DFCM exemption from IBC 2" edge molding..

D. Acoustical sealants.

1.4 INSTALLATION

A. Installation: UBC Standard 25-2.

END OF SECTION 09511

SECTION 09512 - ACOUSTICAL TILE CEILINGS

1.1 SUMMARY

A. Acoustical tiles directly attached to substrates with adhesive.

1.2 QUALITY ASSURANCE

A. Acoustical Tile Quality Standard: ASTM E 1264.

1.3 MATERIALS

A. Acoustical Ceiling Tiles:

1. Type III, mineral base with painted finish; Form 4, cast.
2. Color:White
3. Pattern: D (fissured).
4. LR: Not less than 0.70.
5. NRC: Not less than 0.70.
6. CAC: Not less than 25.
7. Thickness: 3/4 inch.
8. Modular Size: 12 by 12 inches.

B. Metal Edge Moldings and Trim: Extruded aluminum.

C. Acoustical sealants.

END OF SECTION 09512

SECTION 09651 - RESILIENT FLOOR TILE

1.1 PRODUCTS

A. Vinyl Composition Floor Tile:

1. Class: Through pattern.
2. Wearing Surface: Smooth.
3. Thickness: 0.125 inch.
4. Size: 12 by 12 inches.

B. Installation Materials:

1. Trowelable leveling and patching compounds.
2. Adhesives.
3. Seamless-installation accessories.
4. Floor polish.

1.2 FLOOR TILE INSTALLATION

A. Lay tiles in pattern indicated.

END OF SECTION 09651

SECTION 09652 - RESILIENT SHEET FLOORING

1.1 PRODUCTS

A. Vinyl Sheet Floor Covering:

1. Unbacked: 0.080 inch thick.
2. Wearing Surface: Smooth in dry areas, or embossed in wet areas.
3. Sheet Width: As standard with manufacturer.
4. Seaming Method: Heat welded.

B. Installation Materials:

1. Trowelable leveling and patching compounds.
2. Adhesives.
3. Seamless-installation accessories.
4. Integral-flash-cove-base accessories.
5. Floor polish.

1.2 INSTALLATION

A. Integral-Flash-Cove Base: Cove floor coverings 4 inches up vertical surfaces.

END OF SECTION 09652

SECTION 09653 - RESILIENT WALL BASE AND ACCESSORIES

1.1 PRODUCTS

A. Resilient Base: Only for hard surface floors.

1. Type (Material Requirement): TS (rubber, vulcanized thermoset).
2. Group (Manufacturing Method): I (solid).
3. Style: Cove (with top-set toe) for vinyl tile and sealed concrete
4. Minimum Thickness: 0.125 inch.
5. Height: 4 inches.
6. Lengths: Coils in manufacturer's standard length.
7. Outside Corners: Job formed.
8. Inside Corners: Job formed.
9. Surface: Smooth.

B. Resilient Molding Accessory: Rubber.

1. Transition strips.
2. Stair treads.
3. Stair risers.
4. Stair skirting.

C. Installation Materials:

1. Trowelable leveling and patching compounds.
2. Adhesives.

END OF SECTION 09653

SECTION 09680 - CARPET

1.1 SUMMARY

A. Broadloom in bedrooms only

1.2 MATERIALS

A. Woven Carpe:t Shaw Contract Group “Movement” (on State Contract):

1. Fiber Content: 100 percent eco solution q nylon 88% solution syed/ 12% yarn dyed
2. Pile Characteristic: Loop pile.
3. Density: 6,109 oz./cu. yd.
4. Pile Thickness: 0.165 inches
5. Face Weight: 28 oz./sq. yd.

1.3 INSTALLATION

A. Installation Method: Direct glue down.

B. Carpet base accent color at all carpeted areas, not rubber base.

END OF SECTION 09680

SECTION 09681 - CARPET TILE

1.1 SUMMARY

A. Carpet tile- all carpeted areas except bedrooms.

1.2 MATERIALS

A. Carpet Tile: (State Contract- SUU Standard) Subject to compliance with requirements, provide one of the following:

Shaw Contract Group; Kinetic Tile, Style: 59359.

1.3 INSTALLATION

A. Installation Method: Glue down with releasable adhesive.

B. Carpet base accent color at all carpeted areas (not rubber base)

END OF SECTION 09681

SECTION 09912 - INTERIOR PAINTING

1.1 SUMMARY

A. Surface preparation and the application of paint systems on interior substrates.

1.2 QUALITY ASSURANCE

A. Quality Standards: "MPI Approved Products List" and "MPI Architectural Painting Specification Manual."

B. Mockups for each color and finish.

1.3 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. One coat latex block filler, two coats acrylic enamel.

B. Steel Substrates:

1. One coat primer, one coat undercoater, top coat alkyd enamel.

C. Galvanized-Metal Substrates: (roof deck)

1. Water-Based Dry-Fall System: MPI INT 5.3H.

D. Gypsum Board Substrates:

1. 2 coats acrylic enamel over primer, coordinate gloss with SUU- preference may be for semi-gloss.

END OF SECTION 09912

SECTION 10410 - DIRECTORIES

1.1 CHANGEABLE-LETTER DIRECTORIES

A. Enclosed-Face, Changeable-Letter Directories:

1. Perimeter Frame: Aluminum.

a. Aluminum Finish: As designed.

2. Lift-off cover.
3. Header Panel: Not required.
4. Letterboard: Felt, Vinyl or Rubber.
5. Molded-plastic letters.
6. Mounting: Surface.

END OF SECTION 10410

SECTION 10431 - SIGNAGE

1.1 SUMMARY

A. Panel signs, provide signs for all doors in the building.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.3 WARRANTY

A. Materials and Workmanship: Five years.

1.4 PRODUCTS

A. Panel Signs:

1. Interior Panel Signs:

a. Material: Coordinate with SUU sign standard.
b. Mounting: Wall with concealed anchors.
c. Color: As selected by Architect from manufacturer's full range.

1.5 INSTALLATION

A. Wall-Mounted Signs: Mechanical fasteners.

END OF SECTION 10431

SECTION 10522 - FIRE EXTINGUISHER CABINETS

1.1 PRODUCTS

A. Fire Protection Cabinet:

1. Type: For 10# fire extinguisher.
2. Construction: Nonrated or 1-hour fire rated, or 2-hour fire rated- coordinate with wall type.
3. Mounting: Semirecessed.
4. Door Style: Vertical duo panel with frame Center glass panel with frame.
5. Door Glazing: Tempered break glass.
6. Accessories: Door locks.
7. Finish: Door and Frame: Baked enamel or powder coated steel.
8. Body: Steel, baked enamel or powder coated.

END OF SECTION 10522

SECTION 10523 - FIRE EXTINGUISHERS

1.1 SUMMARY

A. Hand-carried fire extinguishers.

1.2 QUALITY ASSURANCE

A. Fire Extinguishers: NFPA 10.

1.3 WARRANTY

A. Materials and Workmanship: Six years.

1.4 PRODUCTS

A. Portable, Hand-Carried Fire Extinguishers:

1. 4A60BC (10#)Multipurpose dry-chemical type, manufacturer's standard container with chrome plated brass valve (aluminum not acceptable).

B. Mounting Brackets: Galvanized steel with identification lettering.

END OF SECTION 10523

SECTION 10550 - POSTAL SPECIALTIES

1.1 SUMMARY

A. Coordinate work with SUU- some existing mailboxes will be reconfigured and reused- also some new boxes will be required..

B. Postal specialties for locations with private mail delivery and collection.

C. Accessories.

1.2 WARRANTY

A. Materials and Workmanship: Five years.

1.3 PRODUCTS

A. Private-Delivery Mail Receptacles: [Match existing.

1. Compartment Doors: [Match existing.
2. Compartment-Door Locks: Match existing.
3. Finish: Match existing.

END OF SECTION 10550

SECTION 10801 - TOILET AND BATH ACCESSORIES

1.1 SUMMARY

A. Public-Use Washroom Accessories:

1. Toilet Tissue Dispenser: Not in Contract- vendor supplied.
2. Paper Towel Dispenser: Not in Contract- vendor supplied.
3. Waste Receptacle: Owner supplied garbage can.
4. Liquid-soap dispenser: Not in Contract- vendor supplied.
5. Grab bar: Stainless Steel, concealed fastners
6. Vendor: Sanitary napkin and tampon, Stainless Steel, Semi-recessed, coin operation.
7. Sanitary-napkin disposal unit: Stainless Steel
8. Mirror unit: Stainless Steel frame.

B. Underlavatory guards. (If using wall mounted sinks)

C. Custodial Accessories:

1. Stainless Steel Mop and broom holder with shelf.

1.2 WARRANTY

A. Silver Spoilage for Mirrors: 15 years.

END OF SECTION 10801

SECTION 11451 - RESIDENTIAL APPLIANCES

1.1 SUMMARY

A. Cooking equipment including ranges and microwave ovens.

B. Ventilation range hoods.

C. Refrigerator/freezers.

D. Freezers.

E. Dishwashers.

F. Clothes washers and dryers.

1.2 QUALITY ASSURANCE

A. Quality Standard: NAECA.

B. Products: UL listed.

1.3 WARRANTY

A. Materials and Workmanship:

1. Electric Range: Five years for surface-burner elements.
2. Microwave Oven: Five years for defects in the magnetron tube.
3. Refrigerator/Freezer: Five years for in-home service on the sealed refrigeration system.
4. Dishwasher: 10 years for in-home service against deterioration of tub and door liner.
5. Clothes Washer: 10 years for the inner wash basket and outer tub, and five years for] the balance suspension system and drive transmission.

1.4 RESIDENTIAL APPLIANCE SCHEDULE

A. Range: Freestanding, electric, white

1. Type: Ceramic-glass cooktop with oven(s).
2. Cooktop: Four burners.
3. Size: 30 inch.
4. Oven(s): One.

B. Microwave oven, 1.6 CF, turntable type, white.

C. Exhaust Hood: Vented to outside- recirculating type not acceptable, provide with grease filter, and task lighting, white.

D. Refrigerator/Freezer: Freestanding, frost-free, two door, freezer over refrigerator, white

E. Dishwasher: Under the counter, stainless steel liner, white

F. Clothes Washer: Freestanding,top loading.

G. Clothes Dryer: Freestanding, electric.

END OF SECTION 11451

SECTION 12491 - HORIZONTAL LOUVER BLINDS

1.1 SUMMARY

A. Horizontal louver blinds with aluminum slats.

1.2 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Passes NFPA 701.

B. Mockups for each form of construction.

1.3 PRODUCTS

A. Horizontal Louver Blinds, Aluminum Slats:

1. Nominal Slat Width: 1 inch.
2. Coating: Antistatic.
3. Tilt Control: Manual with wand.
4. Lift Operation: [Manual with cord.
5. Valance..

1.4 INSTALLATION

A. Mounting: Head.

END OF SECTION 12491

SECTION 14240 - HYDRAULIC ELEVATORS

1.1 SUMMARY

A. Hydraulic passenger elevators.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: ASME A17.1.

1. Effective Peak Velocity Acceleration (Av): 0.20 or more (seismic risk zones 3 and 4).

1.3 WARRANTY

A. Elevator Work: One year.

1.4 MAINTENANCE SERVICE

A. Full Maintenance Service: One year. Also, if elevator manufacturer utilizes timers or cycle counts to disable the elevator, this function shall be turned off and the manufacturer shall provide the Owner with the bypass code.

1.5 COMPONENTS

A. Pump Units: Mounted on oil tank in steel enclosure or submersible pump, suspended inside tank.

1. Motor: Solid-state starting- 208V 3 Phase- verify with SUU.

B. Hydraulic Fluid: Biodegradable and fire resistant.

C. Seismic Protection: Pump unit and hoistway rails shall be anchored per IBC zone 3 requirements.

D. Signal Equipment:

1. Car Control Stations: Recessed one per car.
2. Emergency communication system.
3. Firefighters' two-way telephone communication service.

E. Elevator Description:

1. Cylinder Type: Holeless, telescoping, beside the car.
2. Rated Load: 2500 lb.
3. Rated Speed: 125 fpm.
4. Operation System: Group automatic.
5. Auxiliary Operations:

a. Battery-powered lowering.
b. Automatic dispatching of loaded car.
c. Nuisance call cancel.
d. Independent service for all cars in group.
e. Loaded-car bypass.

6. Inside Width: 80 inches.
7. Inside Depth: 51 inches.
8. Inside Height: 94 inches.
9. Front Walls (Return Panels): Stainless steel.
10. Side and Rear Wall Panels: Plastic laminate.
11. Doors: Textured stainless steel.
12. Ceiling: Luminous ceiling.
13. Handrails: Stainless steel.
14. Threshold: Nickel silver.
15. Floor: Prepared to receive carpet.

16. Hoistway Entrances:

    a. Width: 42 inches.
    b. Height: 84 inches.
    c. Type: Single-speed side sliding.
    d. Frames Stainless steel.
    e. Doors Textured stainless steel.
    f. Threshold: Nickel silver.

17. Hall Fixtures Stainless steel.

END OF SECTION 14240

SECTION 15010 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

A. General Conditions and Division 01 apply to this Division.

1.2 SCOPE

A. Includes -

1. Furnish all labor, materials, and equipment necessary for the completion of the mechanical and plumbing scope of work.
2. Furnish and install all motors specified in this Division and be responsible for the proper operation of electrical powered equipment furnished by this Division.
3. Furnish exact location of electrical connections and information on motor controls to Division 16.
4. Mechanical Contractor shall obtain the services of independent Test and Balance Agency.
5. Placing the air conditioning, heating, ventilating, and exhaust systems into full operation and continuing their operation during each working day of testing and balancing.
6. Making changes in pulleys, belts, and dampers, or adding dampers, as required for the correct balance as recommended by Balancing Contractor at no additional cost to Owner.
7. Air balance, final adjustment and test run.
8. The satisfactory performance of the completed systems is a requirement of this specification.
9. Design build mechanical contractor and engineer shall follow all SUU's design and construction standards found on their web site.

B. Related Work Specified Elsewhere

1. Conduit, line voltage wiring, outlets, and disconnect switches specified in Division 16.
2. Magnetic starters and thermal protective devices (heaters) not a factory mounted integral part of packaged equipment are specified in Division 16.

1.3 SITE OBSERVATION

A. The Contractor should examine the site and understand the existing conditions and site utilities which may affect the performance of work of this Division. Contractor must familiarize himself with the campus roads, parking restrictions staging areas and campus safety regulations during construction.

B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

1.4 DRAWINGS

A. Mechanical drawings shall show general arrangement of piping, ductwork, equipment, etc; follow as closely as actual building construction and work of other trades will permit.

B. Because of the small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Become familiar with new structural and finished conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions.

C. If changes in location of piping, equipment, ducts, etc. are required due to lack of coordination of work under this division, such changes shall be made without charge. Contractor shall review drawings with the university and DFCM and any changes required by them shall be completed prior to commencement of work.

1.5 CODE REQUIREMENTS, FEES, AND PERMITS

A. The work shall be installed in accordance with the following applicable codes, ordinances and standards unless otherwise specified. The codes and standards shall include but not be limited to and be of the latest and current editions.

1. American Boiler and Affiliated Industries (AB and AI)
2. American Gas Association (AGA)
3. Air Movement and Control Association (AMCA)
4. American National Standards Institute (ANSI)
5. Air Conditioning & Refrigeration Institute (ARI)
6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) - ASHRAE 90.1-2004
7. American Society of Mechanical Engineers (ASME)
8. American Society of Testing Materials (ASTM)
9. American Standards Association (ASA)
10. American Water Works Association (AWWA)
11. American Welding Society (AWS)
12. Associated Air Balance Council (AABC)
13. Heat Exchange Institute (HEI)
14. SUU Design Standards
15. BR
16. National Electrical Code (NEC)

17. National Fire Protection Association (NFPA)
18. Sheet Metal and Air Conditioning contractors National Association (SMACNA)
19. Underwriters Laboratories (UL)
20. International Building Code (IBC) 2006 Ed
21. International Mechanical Code (IMC) 2006 Ed
22. International Plumbing Code (IPC) with Utah Amendments 2006 Ed\
23. International Energy Conservation Code (IECC) 2006 Ed
24. Utah State Safety Orders (OSHA/UOSH)
25. Utah Fire Rating Bureau
26. Utah Boiler and Pressure Vessel Law
27. Utah Air Conservation Regulations/Waste Disposal regulations.
28. ASHRAE Ventilation STD.62-2004

B. Should drawings conflict with any code, the code shall govern. If drawings and specifications establish a quality exceeding the code, the drawings and specifications shall govern. Contractor shall comply with applicable codes.

C. The latest edition of all codes shall be used.

D. Contractor shall give all notices, obtain all necessary permits, file necessary plans, prepare documents and obtain approvals, and pay all fees required for completion of the mechanical and plumbing work outlined in this Division of the specifications and shown on the Mechanical Drawings.

1.6 OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL SYSTEMS

A. Upon completion of work and before final payment, Contractor shall furnish and deliver to the Owner, through the Architect and General Contractor, installation, operation and maintenance manuals with instructions for all new materials and equipment used in the building. The contractor shall provide three (3) hard copies of the manuals, and three (3) CD's with electronic copies of the manuals. Electronic information shall be .PDF format. The CD's shall include the same information as the hard copies, and shall be organized in the same manner with electronic bookmarks for each section. CD case and the CD itself shall be labeled the same as the hard copies of the manuals.

B. Bind Operation and Maintenance Manual for Mechanical Systems in a hard-backed piano hinge loose-leaf binder with strong sturdy cover. The project name shall be on the spine and the front of the binder. The front of the binder shall include the following information:

OPERATION
AND
MAINTENANCE
MANUAL
for MECHANICAL SYSTEMS of
(Name of Project)
(Location of Project)
(Date of Project Award)

C. Introduction

1. Title page including name of project, project number, date awarded and date of substantial completion.
2. Second page shall contain the names, phone numbers and addresses of Architect and Consulting Engineers. General Contractor Mechanical Contractor.
3. Third page shall include a Table of Contents for the entire manual.

D. First Section - Summary information including:

1. First page shall contain the contractor's warranties.
2. Second page shall contain a list of names, addresses and phone numbers of contractors and all sub-contractors and work to which each was assigned.
3. Final page or pages shall contain an equipment list. The list shall contain each item of equipment or material for which a submittal was required giving ID or tag no as contained on the drawings make and model No. Serial No. Identification No. Location in building, function along with the name, address, and phone number of the supplier.

E. Second Section - Mechanical Equipment O&M data including:

1. Mechanical maintenance schedule, including a lubrication list when necessary.
2. Mechanical Equipment Operation and Maintenance Data including:

    a. Equipment descriptions
    b. Detailed installation instruction, operating and maintenance instructions. Instructions include in a step by step manner identifying start-up, operating, shutdown and emergency action sequence sufficiently clear so a person unfamiliar with the equipment could perform its operations.
    c. Equipment drawings, performance curves, operating characteristics, etc.
    d. Name addresses and phone number of manufacturer, fabricator and local vender clearly printed or stamped on cover.
    e. Complete parts listing which include catalog number, serial number, contract number or other accurate provision for ordering replacement and spare parts.
    f. Certified drawings, where applicable, showing assembly of parts and general dimensions.

3. Approved Mechanical submittals

F. Third Section - Plumbing Equipment O&M data including:

1. Section shall contain general product catalog cuts, as well as exploded view drawings with parts lists for all valves and other items with multiple parts.
2. Approved Plumbing submittals

G. Fourth Section - Controls O&M data including:

1. Sequence of Operation
2. Description of each operating system included location of switches, breakers, thermostats, and control devices. Provide a single line diagram, showing set points, normal operating parameters for all loads, pressures, temperatures and flow check points; Describe all alarms and cautions for operation.
3. Provide schematic control diagrams, panel diagrams, wiring diagrams, etc. for each separate fan system, chilled water system, hot water system, exhaust air system, pumps, etc. Each control diagram shall show a schematic representation of mechanical equipment and location of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, etc. The correct reading for each control instrument shall be marked on the diagram.

H. The Fifth Section shall contain a complete air and water test and balance report. The report shall contain the name, address and phone number of the agency. It shall also include:

1. Floor plans showing all air openings and thermometer locations clearly marked and cross referenced with data sheets. Format may be 8 1/2 x 11 or 11x14 if legible.
2. Data sheets showing amount of air and water at each setting. See sections 15950.
3. List of equipment with date of last calibration.

I. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes but are to be delivered separate with the maintenance manuals.

J. See the following checklist for assistance in assembling manual:

Item #	**Description**	**Y, N, or NA**
1.	3 ring heavy duty binder with Project name, number and date on cover and project name on spine.	
2.	O&M manual on CD (with label on CD matching label on manual). Electronic copy shall be a PDF file with bookmarks that match the tabs in the hard copy.	
3.	Title Page [including project name, number, address, date awarded, date of substantial completion]	
4.	Second Page Contact List [including architect (if applicable), mechanical engineer, mechanical contractor, and general contractor (if applicable)]	
5.	Table of Contents	
6.	**Section 1 - Summary**	
A.	Warranty	
B.	Mechanical's Sub-contractor List	
C.	Vendor List	
D.	Equipment List	
7.	**Section 2 – Mechanical Equipment**	

A.	Maintenance Schedule (including lubrication list)	
B.	Mechanical Equipment O&M Data (for each piece of equipment submitted) per specifications	
C.	Approved mechanical submittals	
8.	**Section 3 – Plumbing Equipment**	
A.	Plumbing equipment O&M data	
B.	Approved plumbing submittals	
9.	**Section 4 - Controls**	
A.	Sequence of Operation	
B.	Controls diagrams	
C.	Controls Equipment	
10.	**Section 5 – Test and Balance Report**	
A.	Complete Test and Balance Report per specifications	

1.7 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Contractor shall instruct building maintenance personnel in the operation and maintenance of the installed mechanical systems utilizing the Operation and Maintenance Manual when so doing.

B. Minimum instruction periods shall be six hours

C. Instruction periods shall occur before final site observation when systems are properly working and before final payment is made.

D. An additional two hours of instruction will be provided by each contractor, after 60 days of system operation by owner to insure proper system operation and to answer questions.

1.8 RECORD DRAWINGS

A. Contractor shall keep an up-to-date set of mechanical and plumbing drawings in his custody showing all changes in red, clearly defined and neatly drafted by him. At the end of construction, he shall turn these drawings over to the Owner. Record drawings must be completed and submitted prior to final site observation

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PART 2 - PRODUCTS
(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION 15010

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Touchup Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Sleeves.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

B. All materials, piping, etc. shall be new, and domestically made of the best commercial quality obtainable, consistent with specified materials and for the purpose or function intended unless specifically approved in writing prior to bid.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. Project flanges, fittings and piping specialties from moisture and dirt.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

D. Coordinate connection of mechanical and plumbing systems with exterior underground utilities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.
g. Prior Approved Equal.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.
e. Prior Approved Equal.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.
h. Prior Approved Equal.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.
e. Prior Approved Equal.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.
c. Prior Approved Equal.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.
e. Prior Approved Equal.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
   e. Linkseal.
   f. Prior Approved Equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

B. Drawings shall indicate general location and arrangement of piping systems. Drawings do not have to show every offset, or bend that may be required. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install all piping at right angles and parallel to building walls. Diagonal runs are prohibited.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections. Notching of piping or bending of pipe to form fitting is not allowed.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Provide and install escutcheons for penetrations of walls, ceilings, and floors any other location where penetrating will be visible to public.

M. Provide and install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is provided.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.7 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 15050

SECTION 15055 - MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes basic requirements for factory installed motors.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

1.4 SUBMITTALS

A. Provide with equipment.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain field-installed motors through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:

1. Compatible with the following:

    a. Magnetic controllers.
    b. Multispeed controllers.
    c. Reduced-voltage controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

A. Motor requirements apply to factory installed motors except as follows:

1. Different ratings, performance, or characteristics for motor are specified in another Section.
2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

A. Motors 1 HP and Larger: Three phase.

B. Motors Smaller Than 1 HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 5800 feet above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open dripproof indoors and totally enclosed on exterior.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium, as defined in NEMA MG 1.

C. Stator: Copper windings.

1. Multispeed motors shall have separate winding for each speed.

D. Rotor: Squirrel cage, unless otherwise indicated.

E. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating, unless otherwise indicated.

G. Insulation: Class F, unless otherwise indicated.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Designed with critical vibration frequencies outside operating range of controller output.
2. Temperature Rise: Matched to rating for Class B insulation.
3. Insulation: Class H.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating

of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

E. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 15055

SECTION 15060 - HANGERS AND SUPPORTS FOR MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for mechanical system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment supports.

B. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 13 Section "Fire-Suppression Piping" for pipe hangers for fire-suppression piping.
3. Division 15 Section "Vibration and Seismic Controls for Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. AAA Technology & Specialties Co., Inc.
2. B-Line Systems, Inc.; a division of Cooper Industries.
3. Carpenter & Paterson, Inc.
4. Empire Industries, Inc.
5. Grinnell Corp.
6. GS Metals Corp.
7. National Pipe Hanger Corporation.

8. Piping Technology & Products, Inc.
9. Prior approved equal.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. GS Metals Corp.
3. Grinnel Corp.
4. Thomas & Betts Corporation.
5. Unistrut Corp.
6. Prior approved equal.

C. Coatings: Manufacturer's standard finish.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. Pipe Shields, Inc.
3. Rilco Manufacturing Company, Inc.
4. Value Engineered Products, Inc.
5. Prior approved equal.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. Hilti, Inc.
b. ITW Ramset/Red Head.
c. Masterset Fastening Systems, Inc.
d. MKT Fastening, LLC.
e. Powers Fasteners.
f. Prior approved equal.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
3. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
4. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
5. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
6. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
8. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
9. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
10. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

G. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
10. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

H. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

I. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

J. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

K. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

L. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. "Plumbing Fixtures" for plumbing fixtures.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Piping Operating above and below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

b. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40, protective shields on piping. Shields shall span an arc of 180 degrees.

3. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

4. Insert Material: Length at least as long as protective shield.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe after insulation.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9

END OF SECTION 15061

SECTION 15074 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Freestanding and restrained spring isolators.
4. Housed spring mounts.
5. Spring hangers.
6. Spring hangers with vertical-limit stops.
7. Pipe riser resilient supports.
8. Resilient pipe guides.
9. Seismic snubbers.
10. Restraining braces and cables.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Per owner's design standards.
2. Building Classification Category: As defined in the IBC.
3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class: As defined in the IBC.
2. Assigned Seismic Use Group or Building Category: As defined in the IBC.

a. Component Importance Factor: 1.5.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

C. Welding certificates.

D. Qualification Data: For professional engineer and testing agency.

E. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Prior approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene or rubber.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

H. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

I. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

J. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Prior approved equal.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2.3 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. Hilti, Inc.
3. Kinetics Noise Control.
4. Mason Industries.
5. Unistrut; Tyco International, Ltd.
6. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: -steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 7 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

3. Brace a change of direction longer than 12 feet.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 15 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Leave a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

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

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 15074

SECTION 15075 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment signs.
3. Access panel and door markers.
4. Pipe markers.
5. Valve tags.
6. Valve schedules.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping. Colors of piping in Mechanical rooms shall match university color code.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Equipment manufacturer shall provide metal, nameplates, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

    a. Manufacturer, product name, model number, and serial number.
    b. Capacity, operating and power characteristics, and essential data.
    c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment. Adhesive is not acceptable.

B. Equipment Signs: Provided by contractor. ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Equipment name and number, capacity, HP ie pump P-1, 100 gpm @ 50ft. ad 5hp.
2. Engraving: Manufacturer's standard letter style, 1/4” or larger with terms to match equipment identification.
3. Thickness: 1/8 inch, unless otherwise indicated.
4. Fasteners: Self-tapping, stainless-steel screws.

C. Access Panel and Door Markers: Provide 1 1/16” thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8” center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with SUU color standards and ASME A13.1, if color standards are not available.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Provide full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Provide either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Engineer. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.4 VALVE SCHEDULES

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

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Equipment manufacturer shall install and permanently fasten equipment nameplates on each major item of mechanical equipment. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, heaters, etc.
2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, and similar equipment.
4. Fans and blowers.
5. Packaged fan coil units.

B. Install equipment signs with screws on or near each major item of mechanical equipment listed above and below. Locate signs where accessible and visible.

1. Identify mechanical equipment with black equipment markers with white lettering.
2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, GPM, HD, CFM, S.P., HP and identify units.

4. Include signs for the following general categories of equipment:

    a. Fuel-burning units, including boilers, heaters, etc.
    b. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    c. Heat exchangers, coils, evaporators, and similar equipment.
    d. Fans and blowers.
    e. Packaged fan coil units.
    f. Tanks and pressure vessels.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; as follows:

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

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size:

    a. Cold Water: 1-1/2 inches.
    b. Hot Water: 1-1/2 inches.
    c. Gas: 1-1/2 inches.
    d. Steam: 2 inches.

2. Letter Color:

a. Depression black filled numbers not less than ½" high and black filled letters not less than ¼" high.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.7 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 15075

SECTION 15080 - HVAC AND PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

   a. Calcium silicate.
   b. Mineral fiber.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Lagging adhesives.
6. Factory-applied jackets.
7. Field-applied jackets.
8. Tapes.
9. Securements.
10. Corner angles.

B. Related Sections:

1. Division 15 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Calcium Silicate:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Industrial Insulation Group (The); Thermo-12 Gold.
   b. Prior approved equal.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; All-Service Duct Wrap.
   f. Prior approved equal.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000 Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.
   f. Prior approved equal.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
c. Prior approved equal.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-97.
b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
c. Marathon Industries, Inc.; 290.
d. Mon-Eco Industries, Inc.; 22-30.
e. Vimasco Corporation; 760.
f. Prior approved equal.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.
f. Prior approved equal.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.
f. Prior approved equal.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products, Division of ITW; CP-52.
   b. Foster Products Corporation, H. B. Fuller Company; 81-42.
   c. Marathon Industries, Inc.; 130.
   d. Mon-Eco Industries, Inc.; 11-30.
   e. Vimasco Corporation; 136.
   f. Prior approved equal.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
      e. Prior approved equal.

   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: Color-code jackets based on system. Color as selected by Architect.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

   5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.
   d. Prior approved equal.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   e. Prior approved equal.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.
   e. Prior approved equal.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
   e. Prior approved equal.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.
   d. Prior approved equal.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide.

2.9 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Mix insulating cements with clean potable water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top when looking up and bottom when looking down of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for [**100**] [**50**] <**Insert percentage**> percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel aluminum stainless steel, at least 0.040 inch 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, and Flanges.

1. Install insulation over fittings, valves, strainers, flanges, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves and flanges. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange covers are made from sectional pipe insulation, extend insulation from flanges long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Tanks:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Install firestopping at penetrations through fire-rated assemblies.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Fresh air, low pressure, round or rectangular duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

3.12 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:

1. Mineral-Fiber Pipe and Tank: 1 inch thick.

D. Steam-to-hot-water converter insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.

E. Chilled-water pump insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

F. Heating-hot-water pump insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.
2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

G. Chilled-water expansion tank insulation shall be one of the following:

1. Mineral-Fiber Pipe and Tank: 1 inch thick.

H. Heating-hot-water expansion tank insulation shall be one of the following:

1. Calcium Silicate: 2 inches thick.

I. Chilled-water air-separator insulation shall be one of the following:

1. Calcium Silicate - 2 inches thick.
2. Mineral-Fiber Pipe and Tank: 1 inch thick.

J. Heating-hot-water air-separator insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.

3.13 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. Piping System insulation:

1. Hydronic Piping - Mineral Fiber, per chart.
2. Domestic Water Piping -Mineral Fiber, per chart.
3. Horizontal Roof Drain Piping - Mineral Fiber, 1/2”.
4. Steam Piping - Mineral Fiber, per chart.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Minimum Pipe Insulation Thickness from ANSI/ASHRAE/IESNA Standard 90.1-2004

Fluid Design Operating Temp. Range (°F)	Insulation Conductivity		Nominal				
	Conductivity Btu•in./(h•ft^2• F°)	Mean Rating Temp. °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350	0.32-0.34	250	2.5	3.0	3.0	4.0	4.0
251-350	0.29-0.32	200	1.5	2.5	3.0	3.0	3.0
201-250	0.27-0.30	150	1.5	1.5	2.0	2.0	2.0
141-200	0.25-0.29	125	1.0	1.0	1.0	1.5	1.5
105-140	0.22-0.28	100	0.5	0.5	1.0	1.0	1.0
Domestic and Service Hot Water Systems							
105+	0.22-0.28	100	0.5	0.5	1.0	1.0	1.0
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
40-60	0.22-0.28	100	0.5	0.5	1.0	1.0	1.0
<40	0.22-0.28	100	0.5	1.0	1.0	1.0	1.5

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. PVC: 20 mils thick.

3.16 OUTDOOR, FIELD APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Exterior piping, Exposed:

1. Aluminum jacket.

END OF SECTION 15083

SECTION 15110 - VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following general-duty valves:

1. Copper-alloy ball valves.
2. Ferrous-alloy ball valves.
3. Ferrous-alloy butterfly valves.
4. Bronze check valves.
5. Gray-iron swing check valves.
6. Ferrous-alloy wafer check valves.
7. Bronze gate valves.
8. Cast-iron gate valves.
9. Bronze globe valves.
10. Cast-iron globe valves.
11. Chainwheel actuators.

B. Related Sections include the following:

1. Division 2 piping Sections for general-duty and specialty valves for site construction piping.
2. Division 13 fire-suppression piping and fire pump Sections for fire-protection valves.
3. Division 15 Section "Mechanical Identification" for valve tags and charts.
4. Division 15 Section "HVAC Instrumentation and Controls" for control valves and actuators.
5. Division 15 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. SWP: Steam working pressure.
6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set gate, and globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Handwheel: For valves other than quarter-turn types.
3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

1. Threaded: With threads according to ASME B1.20.1.

J. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. One-Piece, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Kitz Corporation of America.
e. NIBCO INC.
f. Watts Industries, Inc.; Water Products Div.

2. Two-Piece, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.

e. Hammond Valve.
f. Kitz Corporation of America.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Watts Industries, Inc.; Water Products Div.
j. Prior approved equal.

3. Three-Piece, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. Hammond Valve.
c. Kitz Corporation of America.
d. NIBCO INC.
e. Prior approved equal.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. One-Piece, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, vented port, and blowout-proof stem.

D. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with vented-port, chrome-plated bronze ball; PTFE or TFE seats, and blowout-proof stem.

E. Three-Piece, Copper-Alloy Ball Valves: Bronze body with vented-port, stainless steel ball; PTFE or TFE seats, and blowout-proof stainless steel stem.

2.4 FERROUS-ALLOY BALL VALVES

A. Manufacturers:

1. Conbraco Industries, Inc.; Apollo Div.
2. Crane Co.; Crane Valve Group; Stockham Div.
3. Hammond Valve.
4. Kitz Corporation of America.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Prior approved equal.

B. Ferrous-Alloy Ball Valves, General: MSS SP-72, with flanged ends.

C. Ferrous-Alloy Ball Valves: Class 150, full port, vented port, with blowout proof stem.

D. Ferrous-Alloy Ball Valves: Class 300, full port.

2.5 FERROUS-ALLOY BUTTERFLY VALVES

A. Manufacturers:

1. Flangeless, Ferrous-Alloy Butterfly Valves:

a. Cooper Cameron Corp.; Cooper Cameron Valves Div.
b. Crane Co.; Crane Valve Group; Center Line.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Grinnell Corporation.
e. Hammond Valve.
f. Kitz Corporation of America.
g. Metraflex Co.
h. Milwaukee Valve Company.
i. Mueller Steam Specialty.
j. NIBCO INC.
k. Tyco International, Ltd.; Tyco Valves & Controls.
l. Watts Industries, Inc.; Water Products Div.
m. Prior approved equal.

2. Flanged, Ferrous-Alloy Butterfly Valves:

a. Cooper Cameron Corp.; Cooper Cameron Valves Div.
b. Grinnell Corporation.
c. Mueller Steam Specialty.
d. Prior approved equal.

3. Grooved-End, Ductile-Iron Butterfly Valves: (Chilled water only)

a. Grinnell Corporation.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Victaulic Co. of America.
f. Prior approved equal.

B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.

C. Flangeless, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer type with one-piece stem.

D. Flanged, 150-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Flanged-end type with one-piece stem.

E. Grooved-End, 175-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Ductile-iron or steel body with grooved or shouldered ends. Chilled water piping only.

2.6 BRONZE CHECK VALVES

A. Manufacturers:

1. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.

c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Red-White Valve Corp.
e. Prior approved equal.

2. Type 3, Bronze, Swing Check Valves with Metal Disc:

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Hammond Valve.
g. Kitz Corporation of America.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell, Wm. Co.
k. Walworth Co.
l. Watts Industries, Inc.; Water Products Div.
m. Prior approved equal.

B. Bronze Check Valves, General: MSS SP-80.

C. Type 1, Class 125, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

D. Type 1, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

E. Type 3, Class 125, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

F. Type 3, Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

2.7 GRAY-IRON SWING CHECK VALVES

A. Manufacturers:

1. Type I, Gray-Iron Swing Check Valves with Metal Seats:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. Hammond Valve.
f. Kitz Corporation of America.
g. Milwaukee Valve Company.
h. Mueller Co.
i. NIBCO INC.
j. Powell, Wm. Co.

k. Walworth Co.
l. Watts Industries, Inc.; Water Products Div.
m. Prior approved equal.

2. Grooved-End, Ductile-Iron Swing Check Valves: (Chilled water only)

a. Victaulic Co. of America.
b. Grinnell Corporation.
c. Mueller Co.
d. Prior approved equal.

B. Gray-Iron Swing Check Valves, General: MSS SP-71.

C. Type I, Class 125, gray-iron, swing check valves with metal seats.

D. 175-psig CWP Rating, Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends. Chilled water piping only.

2.8 FERROUS-ALLOY WAFER CHECK VALVES

A. Manufacturers:

1. Dual-Plate, Ferrous-Alloy, Wafer Check Valves:

a. Mueller Steam Specialty.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Stockham Div.
d. Metraflex Co.
e. NIBCO INC.
f. Watts Industries, Inc.; Water Products Div.
g. Prior approved equal.

B. Ferrous-Alloy Wafer Check Valves, General: API 594, spring loaded.

C. Dual-Plate, Class 125 or 150, Ferrous-Alloy, Wafer Check Valves: Flangeless body.

2.9 BRONZE GATE VALVES

A. Manufacturers:

1. Type 1, Bronze, Nonrising-Stem Gate Valves:

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Hammond Valve.
g. Kitz Corporation of America.

h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell, Wm. Co.
k. Walworth Co.
l. Watts Industries, Inc.; Water Products Div.
m. Prior approved equal.

B. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.

C. Type 1, Class 150, Bronze Gate Valves: Bronze body with nonrising stem and bronze solid wedge.

2.10 CAST-IRON GATE VALVES (Steam and Condensate only)

A. Manufacturers:

1. Type I, Cast-Iron, Nonrising-Stem Gate Valves:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. Grinnell Corporation.
f. Hammond Valve.
g. Kitz Corporation of America.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell, Wm. Co.
k. Walworth Co.
l. Watts Industries, Inc.; Water Products Div.
m. Prior approved equal.

B. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

C. Class 125, NRS, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, nonrising stem, and solid-wedge disc.

D. Class 250, NRS, Bronze-Mounted, Cast-Iron Gate Valves: Cast-iron body with bronze trim, nonrising stem, and solid-wedge disc.

E. Class 250, NRS, All-Iron, Cast-Iron Gate Valves: Cast-iron body with cast-iron trim, nonrising stem, and solid-wedge disc.

2.11 BRONZE GLOBE VALVES

A. Manufacturers:

1. Type 1, Bronze Globe Valves with Metal Disc:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. Hammond Valve.
f. Kitz Corporation of America.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell, Wm. Co.
j. Walworth Co.
k. Prior approved equal.

B. Bronze Globe Valves, General: MSS SP-80, with ferrous-alloy handwheel.

C. Type 1, Class 150, Bronze Globe Valves: Bronze body with bronze disc.

2.12 CAST-IRON GLOBE VALVES (Steam and Condensate only).

A. Manufacturers:

1. Type I, Cast-Iron Globe Valves with Metal Seats:

a. Cincinnati Valve Co.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. Hammond Valve.
f. Kitz Corporation of America.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell, Wm. Co.
j. Walworth Co.
k. Prior approved equal.

B. Cast-Iron Globe Valves, General: MSS SP-85.

C. Type I, Class 250, Cast-Iron Globe Valves: Gray-iron body with bronze seats.

2.13 CHAINWHEEL ACTUATORS

A. Manufacturers:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries, Inc.
3. Prior approved equal.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Sprocket Rim with Chain Guides: Cast iron, of type and size required for valve.

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

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage. Two hole all flanges to pipe.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves (steam only).
2. Throttling Service: Ball or butterfly valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Chilled-Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: Flangeless Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.

4. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 and Larger: 175-psig CWP rating.
5. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
6. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
7. Wafer Check Valves, NPS 2-1/2 and Larger: Dual-plate, wafer, Class 150 ferrous alloy.

D. Domestic Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: One-piece, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
4. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.

E. Heating Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: Flangeless Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.
4. Swing Check Valves, NPS 2 and Smaller: Type 4, Class [**125**] [**150**] [**200**], bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class [**125**] [**250**], gray iron.
6. Wafer Check Valves, NPS 2-1/2 and Larger: Dual-plate, wafer, Class 150, ferrous alloy.

F. Low-Pressure Steam Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Three-piece, 400-psig CWP rating, copper alloy.
2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
3. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
4. Gate Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
5. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
6. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

G. High-Pressure Steam Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Three-piece, 400-psig CWP rating, copper alloy.
2. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 200, bronze.
3. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 250, gray iron
4. Gate Valves, NPS 2 and Smaller: Type , Class 200, bronze.
5. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 250, NRS, bronze-mounted cast iron.
6. Globe Valves, NPS 2 and Smaller: Type 1, Class 200, bronze.
7. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 250, bronze-mounted cast iron.

H. Steam Condensate Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
4. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 250, gray iron.
5. Gate Valves, NPS 2 and Smaller: Class 150, bronze.
6. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, NRS, bronze-mounted cast iron.
7. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
8. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

I. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends,
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End, Chilled water piping Copper Tubing or Steel Piping: Valve ends may be grooved. Do not use for steam or steam condensate piping.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 4 and larger more than 96 inches above floor. Extend chains to 72 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Chilled water only Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

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

END OF SECTION 15110

SECTION 15121 - PIPE EXPANSION FITTINGS AND LOOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following pipe expansion joints and expansion compensation devices for mechanical piping systems:

1. Pipe bends and loops.
2. Alignment guides and anchors.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

A. Product Data: For each type of pipe expansion joint and alignment guide indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

D. Welding certificates.

E. Operation and Maintenance Data: For pipe expansion joints to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers:

a. Adsco Manufacturing, LLC.
b. Advanced Thermal Systems, Inc.
c. Flex-Hose Co., Inc.

d. Flexicraft Industries.
e. Flex-Weld, Inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.
h. Piping Technology & Products, Inc.
i. Senior Flexonics, Inc.; Pathway Division.
j. Prior approved equal.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Stud: Threaded, zinc-coated carbon steel.
2. Expansion Plug: Zinc-coated steel.
3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi minimum. Refer to Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion joints and bends and loops.

B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 15121

SECTION 15126 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.

B. Related Sections:

1. Division 2 Section "Water Distribution" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
2. Division 13 fire-suppression piping Sections for fire-protection pressure gages.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Certificates: For each type of meter and gage, from manufacturer.

C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Miljoco Corporation.
b. Trerice, H. O. Co.
c. Weiss Instruments, Inc.
d. Prior approved equal.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.

a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ashcroft Inc.
b. Marsh Bellofram.
c. Miljoco Corporation.

d. Trerice, H. O. Co.
e. Weiss Instruments, Inc.
f. Prior approved equal.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum or drawn steel; 4 1/2 nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of water chiller.
5. Inlet and outlet of boilers.
6. Inlets and outlets of steam to hot water converter both shell and tube.
7. Inlet and outlet of hot and chilled water coils.

J. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each water pump.
4. Inlet and outlet of boilers.
5. Inlet and outlet of chiller.
6. Inlet and outlet of each hot and chilled water coils.
7. Inlets and outlets of steam to hot water converter both shell and tube.

3.2 CONNECTIONS

A. Install gages adjacent to machines and equipment to allow service and maintenance of gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Industrial-style, liquid-in-glass type.
2. Test plug with EPDM self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:

1. Industrial-style, liquid-in-glass type.

2. Test plug with EPDM self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
1. Industrial-style, liquid-in-glass type.
2. Test plug with EPDM self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each water chiller shall be one of the following:

1. Industrial-style, liquid-in-glass type.
2. Test plug with EPDM self-sealing rubber inserts.

E. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping: 30 to 200 deg F.

C. Scale Range for Steam Piping: 20 to 400 deg F.

D. Scale Range for Chilled Water Piping: 0 to 100 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump, conventor, boilers, chiller, water heater, storage tanks etc. shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi.

B. Scale Range for Heating Hot Water Piping: 0 to 200 psi.

C. Scale Range for Chilled Water Piping: 0 to 200 psi.

D. Scale Range for Steam Piping: 0 to 200 psi.

END OF SECTION 15126

SECTION 15140 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic hot and cold water pipes, tubes, fittings, and specialties inside the building to 5’-0” outside building.
2. Escutcheons.
3. Sleeves and sleeve seals.
4. Wall penetration systems.

B. Related Section:

1. Division 2 Section "Water Distribution" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to 2006 IBC.

1.4 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Water meters.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than 72 hours in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper for all above water piping.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dresser, Inc.; Dresser Piping Specialties.
b. Cascade Waterworks Manufacturing.
c. JCM Industries.
d. Viking Johnson; c/o Mueller Co.
e. Prior approved equal.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products.
g. Prior approved equal.

2. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Prior approved equal.

2. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.6 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew or spring clips.

G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.7 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

2.8 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.
4. Pipeline Seal and Insulator, Inc.
5. Prior approved equal.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.9 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing shall show general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss,

expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install type K copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground type K copper tube in PE encasement according to ASTM A 674 or AWWA C105.

D. Install shutoff valve, hose-end drain valve, strainer, water pressure reducing valve, pressure gages, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 15 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 15 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

G. Install domestic water piping level without pitch and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install seismic restraints on piping. Comply with requirements in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping at right angles and parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping adjacent to equipment and specialties to allow service and maintenance.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping from each plumbing pump. Comply with requirements in Division 15 Section "Meters and Gages for Plumbing Piping" for pressure gages.

T. Install thermostats in hot-water circulation piping. Comply with requirements in Division 15 Section "Domestic Water Pumps" for thermostats.

U. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 15 Section "Meters and Gages for Plumbing Piping" for thermometers.

3.3 JOINT CONSTRUCTION

A. Ream ends of copper tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of tubes and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 15 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 15 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for balancing valves.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.
2. NPS 2 and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

3. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.
3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.

    a. Extend sleeves 2 inches above finished floor level.
    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

    a. PVC pipe sleeves for pipes smaller than NPS 6.
    b. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe Insert type.
5. Sleeves for Piping Passing through Exterior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.
    b. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
    c. Do not use sleeves when wall penetration systems are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply

with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestop materials and installations.

3.10 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 15 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 72 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in piping. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

3. Leave domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 100 psig, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.14 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping before using.
2. Use purging and disinfecting procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to testing lab. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
2. Mechanical-joint, ductile-iron pipe; standard- pattern mechanical-joint fittings; and mechanical joints.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.

G. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.

3.16 VALVE SCHEDULE

A. Drawings shall indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing or ball valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 15140

SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Temperature-actuated water mixing valves.
5. Strainers.
6. Hose bibbs.
7. Wall hydrants.
8. Drain valves.
9. Water hammer arresters.
10. Air vents.
11. Trap-seal primer valves.
12. Trap-seal primer systems.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For domestic water piping specialties to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ames Co.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. FEBCO; SPX Valves & Controls.
   e. Rain Bird Corporation.
   f. Toro Company (The); Irrigation Div.
   g. Watts Industries, Inc.; Water Products Div.
   h. Zurn Plumbing Products Group; Wilkins Div.
   i. Prior approved equal.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Arrowhead Brass Products, Inc.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Legend Valve.
   e. MIFAB, Inc.
   f. Prier Products, Inc.
   g. Watts Industries, Inc.; Water Products Div.
   h. Woodford Manufacturing Company.
   i. Zurn Plumbing Products Group; Light Commercial Operation.
   j. Zurn Plumbing Products Group; Wilkins Div.
   k. Prior approved equal.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.

4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Watts Industries, Inc.; Water Products Div.
   f. Zurn Plumbing Products Group; Wilkins Div.
   g. Prior approved equal.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Accessories:

   a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Hose-Connection Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
   d. Prior approved equal.

3. Standard: ASSE 1052.
4. Operation: Up to 10-foot head of water back pressure.
5. Inlet Size: NPS 1/2 or NPS 3/4.
6. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
7. Capacity: At least 3-gpm flow.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Watts Industries, Inc.; Water Products Div.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Zurn Plumbing Products Group; Wilkins Div.
   e. Prior approved equal.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.
6. Provide with or without integral strainer.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Powers; a Watts Industries Co.
   b. Armstrong International, Inc.
   c. Symmons Industries, Inc.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
   f. Prior approved equal.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Powers; a Watts Industries Co.

b. Armstrong International, Inc.
c. Lawler Manufacturing Company, Inc.
d. Leonard Valve Company.
e. Symmons Industries, Inc.
f. Prior approved equal.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Cabinet-type, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Valve Finish: Chrome plated.
10. Piping Finish: Chrome plated.

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Sloan.
b. Watts.
c. Prior approved equal.

2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 110° F.
9. Tempered-Water Design Flow Rate: Coordinate with 15410.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller;flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Drain: Factory-installed, hose-end drain valve.

2.6 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Chrome.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Woodford Manufacturing Company.
    g. Zurn.
    h. Prior approved equal.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Rough bronze.

12. Operating Keys(s): One with each wall hydrant.

B. Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
   b. Arrowhead Brass Products, Inc.
   c. Watts Industries, Inc.; Water Products Div.
   d. Woodford Manufacturing Company.
   e. Zurn Plumbing Products Group; Light Commercial Operation.
   f. Prior approved equal.

2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig.
6. Operation: Loose key.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Josam Company.

c. MIFAB, Inc.
d. Sioux Chief Manufacturing Company, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products Inc.
h. Zurn.
i. Prior approved equal.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.11 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MIFAB, Inc.
b. PPP Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Industries, Inc.; Water Products Div.
f. Prior approved equal.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.12 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. PPP Inc.
   b. Prior approved equal.

2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Size Outlets: NPS 1/2.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted. Install on hot water recirculating lines where they connect to hot water lines.

E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

   1. Install thermometers.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.

G. Install water hammer arresters in water piping according to PDI-WH 201.

H. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

I. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

J. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings shall indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Water pressure-reducing valves.
4. Calibrated balancing valves.
5. Primary, thermostatic, water mixing valves.
6. Supply-type, trap-seal primer valves.
7. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 15145

SECTION 15150 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water Insert pressure.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS - UNDER FLOOR.

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) ANACO.
2) Fernco, Inc.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.
6) Prior approved equal.

2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) ANACO.
2) Clamp-All Corp.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.
6) Prior approved equal.

3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) MG Piping Products Co.
2) Prior approved equal.

2.5 PVC PIPE AND FITTINGS BELOW GRADE ONLY.

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings standard, shielded, stainless-steel couplings; and hubless-coupling joints.

B. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; standard, and heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

C. Aboveground, vent piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

D. Underground, soil, waste, and vent piping shall be any of the following:

1. Extra-Heavy class, cast-iron soil piping; gaskets; and gasketed calking materials; joints.
2. Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 2 Section "Sanitary Sewerage."

B. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers. Provide concrete around manhole.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."

F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

J. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

K. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

M. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook".

D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.5 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."

B. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

3. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 15 Section "Hangers and Supports."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings shall indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 72 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in piping. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.

Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15150

SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Floor sinks.
4. Roof flashing assemblies.
5. Through-penetration firestop assemblies.
6. Miscellaneous sanitary drainage piping specialties.
7. Flashing materials.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer, rated capacities, operating characteristics, and accessories for the following:

1. Cleanouts.
2. Floor drains.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
   g. Prior approved equal.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Locate in accessible locations.

B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.

g. Zurn Plumbing Products Group; Specification Drainage Operation.
h. Prior approved equal.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Threaded.
8. Closure: Cast-iron plug.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze or copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Prior approved equal.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Zurn.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Prior approved equal.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Top or Strainer Material: Stainless steel.
8. Top Shape: Round.
9. Top Loading Classification: Medium Duty.
10. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
11. Trap Pattern: Deep-seal P-trap.
12. Trap Features: Trap-seal primer valve drain connection.

2.3 FLOOR SINK

A. 12x12x6 with square top, medium receptor cast iron body with flanged receptor, acid resistant coated interior, and acid resistant coated half grate. Aluminum sediment bucket and 3 inch caulked regular outlet connection and deep seal P-Traps.

B. Approved Manufacturers:

1. American Standard 7764
2. Kohler 6454
3. Smith 3411
4. Wade W9100
5. Zurn 1900
6. Prior approved equal.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.
c. Prior approved equal.

B. Description: Manufactured assembly made of copper flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ProSet Systems Inc.
   b. Prior approved equal.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

   a. NPS 2: 4-inch- minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.7 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft. thickness.
2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

   a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
   b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
   c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

I. Install deep-seal traps on all floor drains.

J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

M. Install vent caps on each vent pipe passing through roof.

N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15155

SECTION 15170 - EXTERIOR STEAM DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes piping for steam distribution systems outside the building. Piping includes pipes, fittings, valves, insulation, and specialties for the following:

1. Direct-bury, bare piping with field-installation, loose-fill insulation.
2. Direct-bury, conduit piping system.
3. Tie into existing campus high pressure steam and condensate piping.

B. Related Sections include the following:

1 Division 3 Section "Cast-in-Place Concrete" for lightweight concrete aggregate used in conduit systems for pipe supports.
2 Division 15 Section "Steam and Condensate Piping" for steam and condensate piping systems inside the building.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic piping materials:

1 PTFE: Polytetrafluoroethylene plastic.
2 RTRP: Fiberglass, reinforced-thermosetting-resin pipe.

B. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula Btu x in./h x sq. ft. x deg F or W/m x K at the temperature differences specified. Values are expressed as Btu or W.

1. Example: Apparent Thermal Conductivity (k-Value): 0.26 or 0.037.

1.4 SUBMITTALS

A. Product Data: Include carrier piping, insulation type and k-value, casing, and major components for each conduit piping system.

B. Product Data: Include carrier piping, insulation type and k-value, jacket, end seals, and major components for each cased piping system.

C. Product Data: For loose-fill pipe insulation.

D. Product Data: For steam traps and air vents.

E. Shop Drawings: Detail fabrication of anchors, alignment guides, supports, and expansion loops, for loose-fill insulation system.

F. Installer Certificates: Welders' certificates for welding processes and operators.

G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

H. Warranties: Special warranties specified in this Section.

1.5 DESIGN

A. Manufacturer shall provide complete design of the piping system to allow for thermal movement of the pipe, within allowable stresses. System design shall be in strict accordance with ANSI B31.1. Design/build contractor shall provide details for both the direct buried loose-fill insulation and the steam conduit system.

1.6 COORDINATION

A. Coordinate pipe-fitting pressure classes with products specified in related Sections to allow matching of flange boltholes.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty, executed by Contractor, to repair dry, testable, conduit systems and replace components damaged by failure.

1. Warranty Period: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Steam Traps and Air Vents:

    a. Armstrong International, Inc.
    b. Barnes & Jones, Inc.
    c. ITT Fluid Technology Corp.; ITT Fluid Handling; Hoffman Specialties Div.
    d. Spirax Sarco, Inc.
    e. Sterling, Inc.
    f. Watson McDaniel Co.

2.2 PIPES AND TUBES

A. General: Applications of the following pipe and tube materials are indicated in schedules at the end of Part 3.

B. Steel Pipe, 2-Inch NPS and Smaller: ASTM A 53; Type S, seamless; Grade A; Schedule 40; and plain ends, unless otherwise indicated.

C. Steel Pipe, 2-1/2-to 10-Inch NPS: ASTM A 53; Type E, electric-resistance welded; Grade A; Schedule 40; and plain ends, unless otherwise indicated.

D. Steel Pipe Nipples, 10-Inch NPS and Smaller: ASTM A 733, Schedule 40, seamless, carbon-steel pipe complying with ASTM A 53.

2.3 PIPE AND TUBE FITTINGS

A. General: Applications of the following pipe and tube fitting materials are indicated in schedules at the end of Part 3.

B. Malleable-Iron Unions: ASME B16.39 malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends, with threads according to ASME B1.20.1.

C. Malleable-Iron, Threaded Fittings: ASME B16.3, Class 150, with threads according to ASME B1.20.1. Furnish Class 300 if required to match piping.

D. Cast-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern, with threads according to ASME B1.20.1. Furnish Class 250 if required to match piping.

E. Cast-Iron, Threaded Flanges: ASME B16.1, Class 125, raised ground face, boltholes spot faced. Furnish Class 250 if required to match system, operating pressure, or companion flanges.

F. Steel Flanges and Flanged Fittings: ASME B16.5, steel; including bolts, nuts, and gaskets, butt-welded end connection, and raised face. Furnish with dimensions to match companion flanges.

G. Steel Welding Fittings: ASTM A 234/A 234M, seamless or welded.

2.4 PIPING: (UNDERGROUND CONDUIT SYSTEM) ALTERNATE 1.

A. The underground exterior steam and condensate return piping, shall be installed in an insulated underground piping system to enclose and provide mechanical and waterproofing protection for free unrestricted movement of piping specified. The system supplier shall have at least five years experience fabricating systems on this kind. All components of this system shall be made in the USA and shall be so stamped or labeled.

1. General

   a. All underground steam and condensate return lines as indicated on contract drawings provided by design/build contractor shall be the drainable and dryable type.
   b. All straight sections, fittings, anchors and other accessories shall be factory prefabricated to job dimensions and designed to minimize the number of field welds.
   c. Each system layout shall be computer analyzed by the piping system manufacturer to determine stresses on the carrier pipe and anticipated thermal movement of the service pipe.
   d. The system design shall be in strict conformance with ANSI B31.1, latest edition. Factory trained field technical assistance shall be provided for the critical periods of installation, i.e., unloading, field joint instruction and testing.

2. Service Pipe

   a. Internal steam piping shall be standard weight Schedule 40 carbon steel. Condensate piping, shall be Schedule 80 carbon steel.
   b. All joints shall be butt-welded for sizes 2-1/2 inches and greater, and socket welded for 2 inches and below.
   c. Where possible, provide straight sections in 40 foot random lengths with 6 inches of piping exposed at each end for field joint fabrication.

3. Sub-Assemblies

   a. End seals, gland seals, and anchors shall be designed and factory prefabricated to prevent the ingress of moisture into the system.
   b. All sub-assemblies shall be designed to allow for complete draining and drying of the conduit system.

4. Insulation

a. Service pipe insulation shall be mineral wool. Split insulation shall be held in place by stainless steel bands installed not more than 18 inches apart.
b. The insulation shall have passed the most recent boiling test and other requirements specified in the Federal Agency Guidelines Specifications.
c. The insulation shall be applied to a thickness of 1-1/2 inches for the steam piping and 1 inch for the condensate return piping.

5 Outer Conduit

a. The steel conduit casing shall be smooth wall, welded spiral steel conduit of the thickness specified below.

Conduit Size	Conduit Thickness
6" - 26"	10 gauge

6. Outer Conduit Insulation and Jacket

a. Conduit insulation shall be spray applied polyurethane foam, having a nominal 2 lb/ft^3 density for all straight lengths and fittings. The insulation thickness shall be 1 inch maximum.
b. Quality assurance procedures for the insulation shall include either a visual check prior to jacketing, an infrared inspection or an x-ray inspection of the entire length to insure there are no insulation voids.
c. The urethane foam shall have the minimum characteristics of 0.16 K-factor, density of $2lb/ft^3$ and a closed cell content of 90 to 95%.
d. The outer jacket shall be fiberglass (FRP) and shall be applied directly onto the urethane foam insulation. PVC or polyethylene jackets are not allowed. All straights and fittings shall be factory jacketed.

7. Pipe Supports

a. All pipes within the outer casing shall be supported at not more than 10 foot intervals. These supports shall be designed to allow for continuous airflow and drainage of the conduit in place. The straight supports shall be designed to occupy not more than 10% of the annular air space.
b. Supports shall be of the type where insulation thermally isolates the carrier pipe from the outer conduit. Supports which directly contact both the carrier pipe and the outer casing shall not be allowed. The surface of the insulation shall be protected at the support by a sleeve not less than

12 inches long, fitted with traverse and where required, rotational arresters.

B. Approved Manufacturers -

1. Multi-Therm 500 by Perma Pipe
2. Ricwill
3. Uricon
4. Thermacore

2.5 LOOSE-FILL INSULATION

A. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium-potassium aluminum silicate with calcium-carbonate filler. Include chemical treatment that renders insulation hydrophobic.

1. Thermal Conductivity (k-Value): 0.60 at 175 deg F and 0.65 at 300 deg F.

   a. Dry Density: 40 to 42 lb/cu. ft.
   b. Strength: 12,000 lb/sq. ft.

B. Powder, Loose-Fill Insulation: Inert, nontoxic, nonflammable, calcium-carbonate particles. Include chemical treatment that renders insulation hydrophobic.

1 Thermal Conductivity (k-Value): ASTM C 177, 0.58 at 100 deg F and 0.68 at 300 deg F.
2 Dry Density: Approximately 60 lb/cu. ft.
3 Strength: 12,000 lb/sq. ft.

2.6 JOINING MATERIALS

A. General: Applications of the following piping joining materials are indicated in schedules at the end of Part 3.

B. Refer to Division 2 Section "Utility Materials" for commonly used joining materials.

C. Gasket Materials: ASME B16.21, nonmetallic, asbestos free, and suitable for system liquid design temperatures and pressures.

D. Welding Materials: Comply with the ASME Boiler and Pressure Vessel Code: Section II, Part C, for materials appropriate for pipe being welded.

E. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.7 VALVES

A. Cast-Iron Gate Valves: MSS SP-70; Class 125; ASTM A 126 cast-iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, PTFE-impregnated packing with two-piece packing gland assembly, flanged-end connections; with cast-iron handwheel.

B. Ball Valves: MSS SP-110; 600-psig cold working-pressure rating; ASTM B 584 bronze body and bonnet, two-piece construction, chrome-plated brass ball, conventional port, blowout-proof, bronze or brass stem; PTFE seats and seals; threaded-end connections; stem extension; and vinyl-covered steel lever handle.

2.8 STEAM TRAPS

A. Float-and-Thermostatic Steam Traps: ASTM A 278, Class No. 30 cast-iron body and bolted cap; renewable, stainless-steel float mechanism, with renewable, hardened stainless-steel head and seat; balanced-pressure thermostatic air vent made of stainless-steel or Monel bellows with stainless-steel head and seat.

1. Material Option: ASTM A 126, cast-iron body.

B. Inverted-Bucket Steam Traps: ASTM A 278, Class No. 30 (ASTM A 278M, Class No. 150) cast-iron body and cap, pressure rated for 250 psig; stainless-steel head and seat; stainless-steel valve retainer, lever, guide-pin assembly, brass or stainless-steel bucket.

2.9 AIR VENTS

A. Bellows, Air Vents: Cast-iron, brass, or stainless-steel body, pressure rated for 250 psig. Include balanced-pressure, stainless-steel or Monel, thermostatic bellows; stainless-steel heads and seats; and threaded-vent and -end connections.

2.10 STRAINERS

A. Y-Pattern Strainers: 250-psig minimum steam working pressure; body of cast iron complying with ASTM A 278, Class No. 30 (ASTM A 278M, Class No. 150). Include manufacturer's recommended stainless-steel mesh screen for 2-inch NPS and smaller, and manufacturer's recommended perforations for 2-1/2-inch NPS and larger; tapped blow-off plug; and threaded-or flanged-end connections.

1. Material Option: ASTM A 126, cast-iron body.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Below Grade

1. Before connecting into the existing high pressure steam system, Contractor shall have approval from the Physical Plant Department.

3.2 TRENCHING, LOOSE-FILL INSULATION, AND BACKFILLING

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling for underground piping.

B. Install loose-fill insulation and accessories according to manufacturer's written instructions.

3.3 INSTALLATION OF CONDUIT PIPING

A. The installing contractor shall handle the system in accordance with the directions furnished by the manufacturer and as approved by the Engineer.

B. The casing shall be air tested at 15 psig and the service piping shall be hydrostatically hammer tested to 150 psig or 1 1/2 times the operating pressure, or as specified in the contract documents. The test pressure shall be held for not less than one hour.

C. The contractor shall holiday test the entire conduit system at 5,000 volts. All holidays shall be repaired and tested.

D. Backfill

1. A 4 inch layer of sand or fine gravel shall be placed and tamped in the trench to provide a uniform bedding for the conduit.
2. The entire trench shall be evenly backfilled with a similar material as the bedding in 6 inch compacted layers to a minimum height of 6 inches above the top of the insulated piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable excavated soil.

3.4 JOINT CONSTRUCTION

A. Refer to Division 2 Section "Utility Materials" for basic piping joint construction. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

3.5 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and

arrangements were used to size pipe and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

B. Install steam supply piping at uniform grade of 0.2 percent downward in direction of flow.

C. Install condensate return piping at uniform grade of 0.4 percent downward in direction of flow.

D. Install components with pressure rating equal to or greater than system operating pressure.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install branch connections to steam supply mains using 45-degree fittings in main with takeoff out top of main. Use of 90-degree tee fittings is permissible if 45-degree fittings are not practical. If length of branch takeoff is less than 10 feet (3 m), pitch branch piping down toward main at 0.4 percent.

H. Install drains where shown and at low points consisting of tee fitting, 3/4-inch NPS (DN20) ball valve, and short 3/4-inch NPS (DN20) threaded nipple and cap.

I. Make reductions in pipe sizes using eccentric reducer fitting installed with level side down.

J. Install couplings according to manufacturer's written instructions.

K. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals through exterior building walls.

L. Piping Connections: Unless otherwise indicated, make piping connections as specified below:

1 Install unions in piping 2-inch NPS (DN50) and smaller adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.
2 Install flanges in piping 2-1/2-inch NPS (DN65) and larger adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.

M. Install pipe alignment guides on piping that adjoins pipe expansion joints. Secure aboveground pipe alignment guides to piping supports. Anchor underground piping with concrete thrust blocks.

N. Install pipe anchors to prevent stresses from exceeding those permitted by ASME B31.1 and ASME B31.9 and to prevent transfer of loading and

stresses to connected equipment.

1 Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.1, ASME B31.9, and AWS D1.1.
2 Where pipe expansion joints are indicated, install pipe anchors and alignment guides according to expansion joint manufacturer's written instructions to control movement.

O. Install drip legs at low points of piping and natural drainage points such as ends of mains, bottoms of risers, and upstream of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.

1 Install drip legs on straight piping with no natural drainage points, at intervals not exceeding 200 feet (60 m) if pipe is pitched down in direction of steam flow, and at maximum of 150 feet (45 m) if pipe is pitched up in direction of steam flow.
2 Size drip legs full size of pipe at vertical risers and extend beyond rise. Size drip legs at other locations same as main. Include 18-inch- (450-mm-) long drip leg for steam mains 6-inch NPS (DN150) and smaller. Include drip legs two pipe sizes smaller than, but not less than, 4-inch NPS (DN100) in steam mains 6-inch NPS (DN150) and larger.
3 Equip drip legs, dirt pockets, and strainer blowdowns with gate valves to allow removal of dirt and scale.
4 Install steam traps close to drip legs.

P. Valve Applications: Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Install valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

a. Shutoff Duty, 2-Inch NPS (DN50) and Smaller: Bronze-body gate valves.
b. Shutoff Duty, 2-1/2-Inch NPS (DN65) and Larger: Cast-iron-body gate valves.

Q. Steam Trap Applications for Systems Operating at 125 PSIG and Less: Use according to the following:

1 Steam Main and Drip Legs: Inverted-bucket traps.
2 Steam Main and Drip Legs: Thermodynamic traps.

R. Install steam traps in accessible locations and within 48 inches of connected equipment.

1. Install gate valve, strainer, and union upstream of each trap; install union, check valve, and gate valve downstream from each trap; unless otherwise indicated.

3.6 IDENTIFICATION INSTALLATION

A. Install continuous plastic underground warning tapes during back-filling of trenches for underground steam distribution piping. Locate 6 to 8 inches below finished grade, directly over piping. Refer to Division 2 Section "Earthwork" for warning-tape materials and devices and their installation.

B. Install pipe markers on aboveground steam distribution piping after pipe insulation has been installed. Refer to Division 2 Section "Utility Materials" for identification materials and devices and their installation.

3.7 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping for testing according to ASME B31.1, ASME B31.9, and as follows:

1 Leave joints, including welds, uninsulated and exposed for examination during test.
2 Isolate equipment. Do not subject equipment to test pressure.
3 Install relief valve set at pressure not more than one-third higher than test pressure.

B. Test steam and condensate piping as follows:

1 Use ambient temperature water. Where there is risk of freezing, air or compatible liquid may be used.
2 Use vents installed at high points to release trapped air while filling system. Use drip legs installed at low points for complete removal of liquid.
3 Subject piping system to hydrostatic test pressure that is not less than 1.5 times design pressure.
4 After hydrostatic test pressure has been applied for 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
5 Prepare a written report of testing.

3.8 CLEANING

A. Inspect finish of exposed, steam and condensate piping, including outlets, valves, specialties, and devices, after installation is complete. Remove burrs, dirt, and debris. Repair damaged finishes including chips, scratches, and abrasions.

B. Clean and flush steam and condensate piping. Remove, clean, and replace strainer screens.

3.9 COMMISSIONING

A. Open valves to fully open position.

3.10 BARE-PIPE SYSTEM SCHEDULE

A. Steam Piping Materials and Joining Method: Include the following:

1 Pipe/Tube: Steel pipe.
2 Fittings: Steel welding.
3 Joining Method: Welding.

B. Condensate Piping Materials and Joining Method: Include the following:

1 Pipe/Tube: Steel pipe.
2 Fittings: Steel welding.
3 Joining Method: Welding.

END OF SECTION 15170

SECTION 15181 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Glycol cooling-water piping.
4. Makeup-water piping.
5. Condensate-drain piping.
6. Blowdown-drain piping.
7. Air-vent piping.
8. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:

1. Division 15 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 125 psig at 225° F.
2. Chilled-Water Piping: 125 psig at 100° F.
3. Glycol Cooling-Water Piping: 125 psig at 100° F.
4. Makeup-Water Piping: 125 psig at 100° F
5. Condensate-Drain Piping: 100° F.
6. Blowdown-Drain Piping: 200° F.
7. Air-Vent Piping: Equal to the pressure of the piping system to which it is attached.
8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 SUBMITTALS

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

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Chemical treatment.
4. Hydronic specialties.

B. Welding certificates.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in operation, and maintenance manuals.

F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.6 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion. Hot Water system only.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: Type L.

B. Wrought-Copper Fittings: ASME B16.22.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.
b. S. P. Fittings; a division of Star Pipe Products.
c. Victaulic Company of America.
d. Prior approved equal.

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings: Chilled water only.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Victaulic Company of America.
    b. Anvil International, Inc.
    c. S. P. Fittings; a division of Star Pipe Products.
    d. Prior approved equal.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Steel Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Victaulic Company of America.
    b. Prior approved equal.

2. Housing: Steel.
3. O-Rings and Pipe Stop: EPDM.
4. Tools: Manufacturer's special tool.
5. Minimum working-pressure rating at.

J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
   f. Prior approved equal.

2. Factory-fabricated union assembly, for minimum working pressure at.

D. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   d. Prior approved equal.

2. Factory-fabricated companion-flange assembly, for minimum working pressure as required to suit system pressures.

2.5 VALVES

A. Gate, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "Valves."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 15 Section "HVAC Instrumentation and Controls."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.
   d. Griswold Controls.
   e. Taco.
   f. Prior Approved Equal

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum.
10. Maximum Operating Temperature: .

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.
   d. Griswold Controls.
   e. Taco.
   f. Tour & Andersson; available through Victaulic Company of America.
   g. Prior approved equal.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum.
11. Maximum Operating Temperature: .

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Bell & Gossett Domestic Pump; a division of ITT Industries.
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Conbraco Industries, Inc.
   e. Spence Engineering Company, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   g. Prior approved equal.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Bell & Gossett Domestic Pump; a division of ITT Industries.
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Conbraco Industries, Inc.
   e. Spence Engineering Company, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   g. Prior approved equal. .

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.6 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett Domestic Pump; a division of ITT Industries.
2. Amtrol, Inc.
3. Armstrong Pumps, Inc.
4. Taco.
5. Prior approved equal.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Diaphragm Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

2.7 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: For heating hot water only. Welded steel construction; working pressure; capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

B. Propylene Glycol: For chilled water system industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, 2 inch and smaller, shall be the following:

1. Type L, hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.
2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, 2-1/2 inch and larger, shall be the following:

1. Type L, hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.

2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Chilled-water piping, aboveground, 2” and smaller, shall be the following:

1. Type L, hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, 2 1/2” and larger shall be the following:

1. Type L, Hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

E. Chilled-water piping installed belowground and within slabs shall be the following:

1. Type , annealed-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] joints. Use the fewest possible joints.
2. RTRP and RTRF with adhesive or flanged joints.

F. Makeup-water piping installed aboveground shall be the following:

1. Type L, Hard drawn-temper copper tubing, wrought-copper fittings, and soldered or screwed joints.
2. Schedule 40 steel pipe: Class 125, cast-iron fittings and threaded joints.

G. Condensate-Drain Piping: Type C, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

H. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

I. Air-Vent Piping:

1. Inlet: Same as service.
2. Outlet: Type, annealed-temper copper tubing with soldered or flared joints.

J. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Design/build drawings shall indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping at right angles and parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, ball valve, and short threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.1 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 15 Section "Valves."

Q. Install unions in piping**,** and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install nipple and ball valve in blowdown connection of strainers 2-1/2 inch and larger. Match size of strainer blowoff connection for strainers smaller than 2 inch.

T. Install expansion loops, anchors, and pipe alignment guides as specified in Division 15 Section "Pipe Expansion Fittings and Loops."

U. Identify piping as specified in Division 15 Section "Mechanical Identification."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping.
2. Adjustable roller hangers and spring hangers for steam piping horizontal piping.
3. Pipe Roller: MSS SP-58, Type 44 supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install bypass chemical feeders in hot water heating hydronic system where indicated, in upright position with top of funnel not more than above the floor. Install feeder in minimum bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

G. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with ball valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 15 Section "Meters and Gages."

3.8 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics: Hot water system only.

B. Fill chilled and hot water systems with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water. Circulate for an additional 8 hours, drain, clean strainer screens and refill with fresh water.

C. Add initial chemical treatment to hot water system and maintain water quality in ranges recommended by WTC for the first year of operation.

D. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:

1. Chilled-Water Piping: Minimum 40 percent propylene glycol.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 6 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as the boilers, chiller, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 15181

SECTION 15182 - STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for LP and HP steam and condensate piping:

1. Pipe and fittings.
2. Strainers.
3. Safety valves.
4. Pressure-reducing valves.
5. Steam traps.
6. Thermostatic air vents and vacuum breakers.
7. Steam and condensate meters.

1.3 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1. HP Steam Piping: 150 psig
2. LP Steam Piping: 30 psig
3. Condensate Piping: 30 psig at 250 deg F.
4. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
5. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.5 SUBMITTALS

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

1. Pressure-reducing and safety valve.
2. Steam trap.
3. Air vent and vacuum breaker.
4. Meter.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify processes and operators according to the following:

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 150 and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 150, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.3 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "Valves."

2.4 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig working steam pressure.

2.5 SAFETY VALVES

A. Bronze or Brass Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Kunkle Valve; a Tyco International Ltd. Company.
   c. Spirax Sarco, Inc.
   d. Watts Water Technologies, Inc.
   e. Prior approved equal.

2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Kunkle Valve; a Tyco International Ltd. Company.
   c. Spirax Sarco, Inc.
   d. Watts Water Technologies, Inc.
   e. Prior approved equal.

2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.

7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6 PRESSURE-REDUCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hoffman Specialty; Division of ITT Industries.
2. Spence Engineering Company, Inc.
3. Spirax Sarco, Inc.
4. Prior approved equal.

B. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

C. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

D. Body: Cast iron.

E. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

F. Trim: Hardened stainless steel.

G. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

H. Gaskets: Non-asbestos materials.

2.7 STEAM TRAPS

A. Float and Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Barnes & Jones, Inc.
   c. Dunham-Bush, Inc.
   d. Hoffman Specialty; Division of ITT Industries.
   e. Spirax Sarco, Inc.
   f. Sterling.
   g. Prior approved equal.

2. Body and Bolted Cap: ASTM A 126, cast iron.

3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

B. Inverted Bucket Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Barnes & Jones, Inc.
   c. Dunham-Bush, Inc.
   d. Hoffman Specialty; Division of ITT Industries.
   e. Spirax Sarco, Inc.
   f. Sterling.
   g. Prior approved equal.

2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.8 VACUUM BREAKERS

A. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc.
   b. Dunham-Bush, Inc.
   c. Hoffman Specialty; Division of ITT Industries.
   d. Johnson Corporation (The).
   e. Spirax Sarco, Inc.
   f. Prior approved equal.

2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.

5. O-ring Seal: EPR.
6. Pressure Rating: 125 psig.
7. Maximum Temperature Rating: 350 deg F.

2.9 CONDENSATE METERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Central Station Steam Co.
2. Lincoln Meter Company.
3. Prior approved equal.

B. Body: Cast iron, bronze, or brass.

C. Turbine: Copper, brass, or stainless steel.

D. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.

E. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.

1. Computer shall have 4- to 20-mA or 2- to 10-volt output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation specified in Division 15 Section "HVAC Instrumentation and Controls."
4. Microprocessor Enclosure: NEMA 250, Type 4.

F. Maximum Temperature Rating: 250 deg F.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping below grade, NPS 2 and smaller, shall be either of the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. RTRP and RTRF with adhesive or flanged joints.

F. Condensate piping below grade, NPS 2-1/2 and larger, shall be either of the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and RTRF with adhesive or flanged joints.

3.2 HP STEAM PIPING APPLICATIONS

A. HP Steam Piping, NPS 2 and Smaller: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. HP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

E. Condensate piping below grade, NPS 2 and smaller, shall be the following:

1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

F. Condensate piping below grade, NPS 2-1/2 and larger, shall be either of the following:

1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
2. RTRP and RTRF with adhesive or flanged joints.

3.3 ANCILLARY PIPING APPLICATIONS

A. Vacuum-Breaker Piping: Outlet, same as service where installed.

B. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the inlet and outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.5 PIPING INSTALLATION

A. Design/build drawing shall indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping at right angles and parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains with the branch connected to top of main pipe.

P. Install valves according to Division 15 Section "Valves."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, anchors, and pipe alignment guides as specified in Division 15 Section "Pipe Expansion Fittings and Loops."

U. Identify piping as specified in Division 15 Section "Mechanical Identification."

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 150 feet.
2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced to 50% of main diameter but to no less than NPS 4.

3.6 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.7 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on both sides of pressure-reducing valves.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.

E. Install pressure gages on both sides of pressure-reducing valves before and after the bypass connection according to Division 15 Section "Meters and Gages."

F. Install strainers upstream of pressure-reducing valve.

G. Install safety valve downstream from pressure-reducing valve station.

3.8 CONDENSATE METER INSTALLATION

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's instructions.

B. Provide data acquisition wiring. Refer to Division 15 Section "HVAC Instrumentation and Controls."

3.9 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, "Power Piping." and ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

3.10 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 15 Section "Hangers and Supports." Comply with requirements below for maximum spacing.

B. Seismic restraints are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Spring hangers to support vertical runs.

D. Install hangers with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.

3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 21 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 24 feet; minimum rod size, 5/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.11 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.12 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install drip leg at convertor and coil outlets to tank heaters.

E. Install a drip leg at coil outlet.

3.13 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Flush system with clean water. Clean strainers.
3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 6 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

END OF SECTION 15182

SECTION 15185 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Close-coupled, in-line centrifugal pumps.
2. Close-coupled, end-suction centrifugal pumps.
3. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Operation and Maintenance Data: For pumps to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Design/build contract drawings shall indicate size, profiles, and dimensional requirements of hydronic. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Bell & Gossett; Div. of ITT Industries.

2. Armstrong Pumps Inc.
3. Aurora Pump; Division of Pentair Pump Group.
4. Flowserve Corporation; Div. of Ingersoll-Dresser Pumps.
5. PACO Pumps.
6. Peerless Pump; a Member of the Sterling Fluid Systems Group.
7. Prior approved equal.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 200 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 15 Section "Motors."

E. Capacities and Characteristics: See Drawings.

2.3 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Bell & Gossett; Div. of ITT Industries.
4. Flowserve Corporation; Div. of Ingersoll-Dresser Pumps.
5. Peerless Pump; a Member of the Sterling Fluid Systems Group.
6. Weinman; Div. of Crane Pumps & Systems.
7. Prior approved equal.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation

with pump and motor shafts mounted horizontally. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.
6. Motor: Variable speed, with permanently lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support. Comply with requirements in Division 15 Section "Motors."

D. Capacities and Characteristics: Provided by design/build contractor.

1. Capacity: <**Insert gpm.**>
2. Total Dynamic Head: <**Insert feet.**>
3. Maximum Operating Pressure: <**Insert feet.**>
4. Maximum Continuous Operating Temperature: <**Insert deg. F.**>
5. Inlet and Outlet Size: <**Insert NPS.**>
6. Impeller Size: <**Insert inches.**>
7. Motor Speed: <**Insert rpm.**>
8. Motor Horsepower: <**Insert value.**>
9. Electrical Characteristics:

   a. Volts: <**Insert value**>.
   b. Phase: <**Insert value**>.
   c. Hertz: 60.
   d. Full-Load Amperes: <**Insert value.**>
   e. Minimum Circuit Ampacity: <**Insert value.**>
   f. Maximum Overcurrent Protection: <**Insert value.**>

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:

1. Bell & Gossett; Div. of ITT Industries.
2. Armstrong Pumps Inc.
3. Aurora Pump; Division of Pentair Pump Group.
4. Bell & Gossett; Div. of ITT Industries.
5. Flowserve Corporation; Div. of Ingersoll-Dresser Pumps.
6. Weinman; Div. of Crane Pumps & Systems.

7. Prior approved equal.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Variable speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 15 Section "Motors."

H. Capacities and Characteristics: See Drawings.

2.5 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast -iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 15 Section "Basic Mechanical Materials and Methods."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.3 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 15 Section "Hangers and Supports."

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls." Hanger and support materials are specified in Division 15 Section "Hangers and Supports."

F. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation and HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings shall indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve and throttling valve or triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping.

I. Install electrical connections for power, controls, and devices.

J. Ground equipment according to Division 16 Section "Grounding and Bonding."

K. Connect wiring according to Division 16 Section "Conductors and Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 1 Section " Demonstration and Training."

END OF SECTION 15185

SECTION 15186 - STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes electric-driven steam condensate pumps.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.

B. Operation and Maintenance Data: For pumps to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain steam condensate pumps through one source from a single manufacturer.

B. Product Options: Design/build drawings shall indicate size, profiles, and dimensional requirements of steam condensate pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store steam condensate pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 ELECTRIC-DRIVEN STEAM CONDENSATE PUMPS

A. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pump(s), controls, and accessories suitable for operation with steam condensate.

B. Configuration: Duplex floor-mounting pump with receiver and float switch(es); rated to pump 200 deg F steam condensate.

C. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 210 deg F steam condensate.

1. Manufacturers:

a. Aurora Pump; Division of Pentair Pump Group.
b. Nicholson Steam Trap; a division of Spence Engineering Company, Inc.
c. Roth Pump Company.
d. Spence Engineering Company, Inc.; Division of Circor International, Inc.
e. Spirax Sarco, Inc.
f. Sterling, Inc.
g. Prior approved equal.

2. Receiver: Floor-mounting, close-grained cast iron or welded steel; externally adjustable float switches; with water-level gage, steam condensate thermometer,

discharge-pressure gage for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.

3. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
4. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges.
5. Control Panel: NEMA 250, Type 2 enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:

    a. Motor controller for each pump.
    b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
    c. Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
    d. Momentary contact "TEST" push button on cover for each pump.
    e. Numbered terminal strip.
    f. Disconnect switch.
    g. Fused transformer for control circuit.

6. Capacities and Characteristics: Shall be on design/build drawings.

    a. Unit Capacity with Single Pump Operation: <**Insert sq. ft. EDR.**>
    b. Capacity, Each Pump:

        1) Flow: <**Insert gpm.**>
        2) Discharge Head: <**Insert psig.**>
        3) Discharge Size: <**Insert NPS.**>
        4) Speed: <**Insert rpm.**>
        5) Motor Horsepower: <**Insert value.**>

    c. Receiver:

        1) Capacity: <**Insert gal..**>
        2) Inlet Size: <**Insert NPS.**>
        3) Height to Inlet: <**Insert inches.**>

    d. Electrical Characteristics:

        1) Volts: <**Insert value**>.
        2) Phase: <**Insert value**>.
        3) Hertz: 60.
        4) Full-Load Amperes: <**Insert value.**>
        5) Minimum Circuit Ampacity: <**Insert value.**>
        6) Maximum Overcurrent Protection: <**Insert value.**>

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine rough installation of steam condensate piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

B. Install thermometers and pressure gages.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install check valve, gate valve, and globe valve at pump discharge connections for each electric-driven pump.

C. Pipe drain to nearest floor drain for overflow and drain piping connections.

D. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

E. Ground equipment according to Division 16 Section "Grounding and Bonding."

F. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 STARTUP SERVICE

A. Verify that steam condensate pumps are installed and connected according to the Contract Documents.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Clean strainers.

D. Set steam condensate pump controls.

E. Set pump controls for automatic start, stop, and alarm operation.

F. Perform the following preventive maintenance operations and checks before starting:

1. Set float switches to operate at proper levels.
2. Check motors for proper rotation.
3. Test pump controls and demonstrate compliance with requirements.
4. Replace damaged or malfunctioning pump controls and equipment.
5. Verify that pump controls are correct for required application.

G. Start steam condensate pumps according to manufacturer's written startup instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps. Refer to Division 1 Section " Demonstration and Training."

END OF SECTION 15186

SECTION 15195 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Mechanical sleeve seals.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

1.5 SUBMITTALS

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

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.

3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.
6. Mechanical sleeve seals.
7. Escutcheons.

B. Welding certificates.

C. Field quality-control reports.

D. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions

and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. OmegaFlex, Inc.
    b. Parker Hannifin Corporation; Parflex Division.
    c. Titeflex.
    d. Tru-Flex Metal Hose Corp.
    e. Prior approved equal.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.

    a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig.

C. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded or flanged or suitable for welded connection.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
b. Outlet shall be threaded or flanged or suitable for welded connection.
c. Bridging sleeve over mechanical coupling.
d. Factory-connected anode.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Plastic Mechanical Couplings,NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Lyall, R. W. & Company, Inc.
2) Mueller Co.; Gas Products Div.
3) Perfection Corporation; a subsidiary of American Meter Company.
4) Prior approved equal..

b. PE body with molded-in, stainless-steel support ring.
c. Buna-nitrile seals.
d. Acetal collets.
e. Electro-zinc-plated steel stiffener.

6. Plastic Mechanical Couplings,NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Lyall, R. W. & Company, Inc.
2) Mueller Co.; Gas Products Div.
3) Perfection Corporation; a subsidiary of American Meter Company.
4) Prior approved equal..

b. Fiber-reinforced plastic body.
c. PE body tube.
d. Buna-nitrile seals.
e. Acetal collets.
f. Stainless-steel bolts, nuts, and washers.

7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Dresser Piping Specialties; Division of Dresser, Inc.
2) Smith-Blair, Inc.
3) Prior approved equal..

b. Steel flanges and tube with epoxy finish.
c. Buna-nitrile seals.
d. Steel bolts, washers, and nuts.
e. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. BrassCraft Manufacturing Company; a Masco company.
   b. Conbraco Industries, Inc.; Apollo Div.
   c. Lyall, R. W. & Company, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Perfection Corporation; a subsidiary of American Meter Company.
   f. Prior approved equal..

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. PE Ball Valves: Comply with ASME B16.40.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Kerotest Manufacturing Corp.
   b. Lyall, R. W. & Company, Inc.
   c. Perfection Corporation; a subsidiary of American Meter Company.
   d. Prior approved equal..

2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

F. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Vanguard Valves, Inc.
   b. Safe-T-Quake.
   c. Koso
   d. Trembler Tech
   e. Prior approved equal.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.

2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Actaris.
   b. American Meter Company.
   c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   d. Invensys.
   e. Richards Industries; Jordan Valve Div.
   f. Prior approved equal..

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

2.7 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, Inc.
   b. Calpico Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Link-Seal.
   f. Prior approved equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.9 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

   1. Finish: Polished chrome-plated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Install fittings for changes in direction and branch connections.

E. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

F. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
e. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated or rough-brass finish.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 15 Section "Meters and Gages."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 15 Section "Hangers and Supports."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 15 Section "Mechanical Identification" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 9 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (flat).
d. Color: By owner.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Quick-drying alkyd metal primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semigloss).
d. Color: By owner.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:

1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.

B. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping shall be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping 2” and larger shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. One-piece, bronze ball valve with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, lubricated plug valve.

END OF SECTION 15195

SECTION 15410 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:

1. Lavatories.
2. Lavatory Faucets.
3. Water closets.
4. Toilet seats.
5. Fixture supports.
6. Protective shielding guards handicapped only.
7. Commercial sinks.
8. Sink Faucets.
9. Service sinks.
10. Disposers.
11. Shower Faucets and Heads.
12. Washer fittings.

B. Related Sections include the following:

1. Division 15 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

E. FRP: Fiberglass-reinforced plastic.

F. PMMA: Polymethyl methacrylate (acrylic) plastic.

G. PVC: Polyvinyl chloride plastic.

H. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Operation and Maintenance Data: For plumbing fixtures to include in operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
2. Vitreous-China Fixtures: ASME A112.19.2M.
3. Water Closet, Tank Trim: ASME 1037.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Faucets: ASME A112.18.1.
4. Hose-Connection Vacuum Breakers: ASSE 1011.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
7. NSF Potable-Water Materials: NSF 61.
8. Pipe Threads: ASME B1.20.1.
9. Supply Fittings: ASME A112.18.1.
10. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1.
4. Hand-Held Showers: ASSE 1014. Handicapped only.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Manual-Operation Flushometers: ASSE 1037.
4. Brass Waste Fittings: ASME A112.18.2.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Floor Drains: ASME A112.6.3.
3. Grab Bars: ASTM F 446.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Pipe Threads: ASME B1.20.1.

6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Protective Shielding Guards: ICC A117.1. Handicapped only.

1.6 WARRANTY

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LAVATORIES

A. Lavatories, Counter Mounted:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Standard.
    b. Commercial Enameling Company.
    c. Eljer.
    d. Kohler Co.
    e. Prior approved equal.

2. Description: Accessible Counter-mounting, vitreous-china fixture.

    a. Type: Self-rimming.
    b. Oval Lavatory Size: 20 by 17 inches.
    c. Faucet Hole Punching: Depends on faucet.
    d. Color: White.
    e. Supplies: NPS 3/8 chrome-plated copper with stops.
    f. Drain: Grid with offset waste.

        1) Location: Near back of bowl.

B. Mixing Valve

1. Valve shall be thermostatic and pressure mixing valve with maximum 5 degree approach temperature.
2. Approved Manufacturers -

    a. Powers hydroguard TP or equal by.
    b. Sloan.
    c. Prior approved equal.

2.2 LAVATORY FAUCETS

A. Lavatory Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Moen, Inc.
   b. American Standard Companies, Inc.
   c. Kohler Co.
   d. Zurn Plumbing Products Group; Commercial Brass Operation.
   e. Prior approved equal.

2. Description: Single-control mixing. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

   a. Body Material: Commercial, solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.2 gpm.
   d. Centers: 4 inches.
   e. Mounting: Deck, concealed.
   f. Spout: Rigid type.
   g. Spout Outlet: Aerator.
   h. Drain: Grid.
   i. Tempering Device: Thermostatic.

2.3 WATER CLOSETS

A. Water Closets, Floor mounted-tank type:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. American Standard Companies, Inc. Cadet 2898.012 for non handicapped or Cadet 2216.143 for handicapped or equal by.
   b. Eljer.
   c. Kohler Co.
   d. Prior approved equal.

2. Description Accessible, where indicated on drawings, Floor-mounting**,** back-outlet, vitreous-china fixture designed for gravity-tank operation.

   a. Style:

      1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
      2) Height: Accessible, where indicated on drawings.
      3) Design Consumption.
      4) Tank: Gravity type with trim. Include cover.
      5) Trip Mechanism: Lever-handle actuator.
      6) Color: White.

2.4 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. American Standard Companies, Inc.
   b. Bemis Manufacturing Company.
   c. Church Seats.
   d. Eljer.
   e. Kohler Co.
   f. Olsonite Corp.

2. Description: Toilet seat for water-closet-type fixture.

   a. Material: Molded, heavy duty, solid, anti-microbial plastic, with fire retardant.
   b. Configuration: Open front with cover.
   c. Hinge Type: Stainless Steel, self-sustaining.
   d. Class: Standard commercial.
   e. Color: White.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Piping Enclosures: Handicapped only.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. TRUEBRO, Inc.
   b. McGuire.
   c. Proflo.
   d. Prior approved equal.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.6 COMMERCIAL SINKS

A. Commercial Sinks, Two Compartment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Elkay Manufacturing Co.
   b. Just Manufacturing Company.
   c. Prior approved equal.

2. Description: Two-compartment, counter mounted stainless-steel commercial sink.

    a. Overall Dimensions: See drawings. Provided by design/build contractors.
    b. Metal Thickness: 18 Gauge.
    c. Compartment:

        1) Dimensions: See drawings. Provided by design/build contractors.
        2) Drain: NPS 1-1/2 tailpiece with stopper.

            a) Location: Centered in compartment.

2.7 SINK FAUCETS

A. Sink Faucets Two compartments :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Moen, Inc.
    b. American Standard Companies, Inc.
    c. Eljer.
    d. Kohler Co.
    e. Zurn Plumbing Products Group.

2. Description: Kitchen faucet without spray. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

    a. Body Material: Commercial, solid brass.
    b. Finish: Polished chrome plate.
    c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
    d. Mixing Valve: Single control.
    e. Mounting: Deck.
    f. Handle(s): Lever.
    g. Spout Type: Swing, solid brass.
    h. Spout Outlet: Aerator.

        Drain: basket strainer

2.8 SERVICE SINKS

A. Service Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Standard Companies, Inc.
    b. Eljer.

c. Kohler Co.
d. Prior approved equal.

2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.

a. Size: 28 by 28 inches.
b. Color: White.
c. Faucet: Sink American Standard 8344.111 with threaded spout and48 inch hose and damp or equal by

1) Eljer.
2) Kohler.
3) Speakman.

d. Drain: Grid with NPS 2 outlet.

2.9 DISPOSERS

A. Disposers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. In-Sink-Erator; a div. of Emerson Electric Co.
b. Franke Consumer Products, Inc.; Kitchen Systems Div.
c. KitchenAid.
d. American Standard Companies, Inc.
e. Maytag Co.

2. Description: Batch-feed household, food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.

a. Type: Batch-feed household.
b. Motor: Overload protection.

2.10 SHOWER FAUCETS

A. Shower Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Moen, Inc.
b. American Standard Companies, Inc.
c. Eljer.
d. Kohler Co.

e. Symmons Industries, Inc.
f. Prior approved equal.

2. Description: Single-handle pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.

   a. Body Material: Solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
   d. Diverter Valve: Integral with mixing valve.
   e. Mounting: Exposed.
   f. Antiscald Device: Integral with mixing valve.
   g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
   h. Shower Head Type: Handicapped ball and joint and Hand hold, hook mounted.
   i. Shower Head Type: Non handicapped.
   j. Shower Head Material: Metallic with chrome-plated finish.
   k. Spray Pattern: Adjustable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

C. Install counter-mounting fixtures in and attached to casework.

D. Install fixtures level and plumb according to roughing-in drawings.

E. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces

behind fixtures. Install stops in locations where they can be easily reached for operation.

F. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

G. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

H. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

I. Install toilet seats on water closets.

J. Install shower flow-control fittings with specified maximum flow rates in shower arms.

K. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

L. Install disposer in outlet of commons area double compartment sink. Install switch in wall adjacent to sink if location is not indicated.

M. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."

N. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings from design/build contractor shall indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust all fixtures. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 15410

SECTION 15415 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following water coolers and related components:

1. Pressure water coolers.
2. Fixture supports.

1.3 DEFINITIONS

A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.

G. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: Equal to 100 percent of amount installed for each type and size indicated, but no fewer than 1 of each.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Water Coolers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkay Manufacturing Co. **model EZSTL8C or equal by**
b. Acorn Aqua.
c. Haws Corporation.
d. Prior approved equal.

2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, Bi-level wall-mounting water cooler for adult and child-mounting height.

    a. Cabinet: Bilevel with two attached cabinets and with bilevel skirt kit,.
    b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
    c. Control: Push bar.
    d. Supply: NPS 3/8 with ball, gate, or globe valve.
    e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
    f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
    g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

        1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
        2) Electrical Characteristics: hp; 120-V ac; single phase; 60 Hz.

    h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    1. Josam Co.
    2. MIFAB Manufacturing, Inc.
    3. Smith, Jay R. Mfg. Co.
    4. Tyler Pipe; Wade Div.
    5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
    6. Zurn Plumbing Products Group; Specification Drainage Operation.
    7. Or equal by.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

    1. Type I: Hanger-type carrier with two vertical uprights.
    2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
    3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set freestanding and pedestal drinking fountains on floor.

D. Set remote water coolers on floor, unless otherwise indicated.

E. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 15 Section "Valves."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 15415

SECTION 15441 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:

1. Wet Rotor Circulators.

1.3 SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Operation and Maintenance Data: For domestic water pumps to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings shall indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 100% LEAD-FREE WET ROTOR CIRCULATORS

A. Manufacturers:

1. Bell & Gossett Domestic Pump; ITT Industries.
2. Armstrong Pumps Inc.
3. Prior approved equal.

B. Description:

1. In-line wet rotor circulation pumps designed specifically for quiet operation in open (potable) water systems. Pumps shall have 100% lead-free bronze or stainless steel bodies.
2. Provide with Aquastat.

C. Construction Materials:

1. Pump Body:

   a. NBF: 100% lead-free bronze.
   b. SSF: Stainless Steel.

2. Bearings: Carbon
3. Impeller:

   a. NBF-33, NBF-36, NBF-45: Noryl.
   b. All Others: Polypropylene.

4. Shaft: Ceramic

D. Operating Data

1. Maximum Working Pressure: 150 psi
2. Maximum Operating Temperature:

   a. NBF-33, NBF-36, NBF-45: 225°F.
   b. All Others: 230°F.

E. Capacities and Characteristics: Provide on drawings.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Manufacturers:

   a. Honeywell International, Inc.
   b. Square D.
   c. White-Rodgers Div.; Emerson Electric Co.
   d. Prior approved equal.

2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
3. Range: 65 to 200 deg F.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac or 120 V, ac.

2.4 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.3 CONTROL INSTALLATION

A. Install immersion-type thermostats in hot-water return piping.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 15 Section "Domestic Water Piping."

1. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 15 Section "Valves" for general-duty valves for domestic water piping and Division 15 Section "Plumbing Specialties" for strainers.
2. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or in suction and discharge piping. Refer to Division 15 Section "Meters and Gages" for pressure gages and gage connectors.

D. Ground equipment according to Division 16 Section "Grounding and Bonding."

E. Connect wiring according to Division 16 Section "Conductors and Cables."

F. Connect thermostats to pumps that they control.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 15441

SECTION 15450 - POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes potable-water storage tanks and related accessories for indoor installation, if storage tank is separated from a packaged boiler system.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories. Indicate dimensions, wall thickness, insulation, finishes and coatings, required clearances, methods of assembly of components, and piping connections.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings shall indicate size, profiles, and dimensional requirements of potable-water storage tank and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. ASME Compliance for Steel Tanks: Fabricate and label steel, potable-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

C. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 to 9," for potable-water storage tanks. Include appropriate NSF marking.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL, PRESSURE, POTABLE-WATER STORAGE TANKS

A. Manufacturers:

1. Ace.
2. Aldrich Co.
3. Lochinvar Corp.
4. Precision Parts Corp.
5. PVI Industries, LLC.
6. Raypak, Inc.
7. Smith, A. O. Water Products Co.
8. State Industries, Inc.
9. Wood, John Co.
10. Prior approved equal.

B. Description: Steel, horizontal or vertical pressure-rated tank with cylindrical sidewalls.

C. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

D. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig working pressure.

E. Manhole: Watertight, for tank more than 36 inches in diameter; same pressure rating as tank.

F. Tappings: Factory-fabricated steel, welded to tank before testing and labeling.

1. NPS 2 and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 and Larger: ASME B16.5, flanged.

G. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Gage glass, brass fittings, compression stops, and gage-glass guard.

H. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank before testing and labeling.

I. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.

J. Tank Interior Finish: Materials and thicknesses complying with NSF 61 barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: Cement or Copper.
2. Coating: Epoxy resin.

K. Exterior Coating: Manufacturer's standard enamel paint.

PART 3 - EXECUTION

3.1 CONCRETE BASE

A. Install concrete base of dimensions indicated for tanks. Refer to Division 15 Section "Basic Mechanical Materials and Methods." For Tanks not part of a packaged unit.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported tanks, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported tanks.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.2 INSTALLATION

A. Install water storage tank on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

1. Install horizontal tanks on fabricated steel supports and saddles.

B. Anchor tank supports and tanks to substrate.

C. Install tank seismic restraints.

D. Install thermometers and pressure gages on water storage tank and piping. Thermometers and pressure gages are specified in Division 15 Section "Meters and Gages."

E. Install the following devices on tank:

1. Temperature and pressure relief valves.
2. Connections to accessories.

F. After installing tank with factory finish, inspect finishes and repair damages to finishes.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings shall indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to potable-water storage tank to allow service and maintenance.

C. Connect water piping to water storage tank with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. General-duty valves are specified in Division 15 Section "Valves."

a. Valves NPS 2 and Smaller: Ball.
b. Valves NPS 2-1/2 and Larger: Ball or butterfly.
c. Drain Valves: NPS 3/4 ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.

2. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Division 15 Section "Basic Mechanical Materials and Methods."

3.4 FIELD QUALITY CONTROL

A. Perform the following final checks before filling:

1. Test operation of tank accessories and devices.
2. Verify that pressure relief valves have correct setting.

a. Manually operate pressure relief valves.
b. Adjust pressure settings.

B. Filling Procedures: Follow manufacturer's written procedures. Fill tanks with water to operating level.

3.5 CLEANING

A. Clean and disinfect potable-water storage tank.

B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:

1. Purge water storage tanks with potable water.
2. Disinfect tanks by one of the following methods:

a. Fill tanks with water-chlorine solution containing at least 50 ppm of chlorine. Isolate tanks and allow to stand for 24 hours.
b. Fill tanks with water-chlorine solution containing at least 200 ppm of chlorine. Isolate tanks and allow to stand for three hours.

3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.

4. Submit water samples in sterile bottles to authorities testing lab. Repeat procedure if biological examination made by authorities having jurisdiction shows evidence of contamination.

C. Prepare written reports for purging and disinfecting activities.

END OF SECTION 15450

SECTION 15469 - WATER SOFTENERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes commercial water softeners. Softeners shall be for the potable hot water only.

1. Chemicals.
2. Water testing kits.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Water Softeners. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. Water testing kits.

B. Shop Drawings: For water softeners. Include plans, elevations, sections, details, and connections to piping systems.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Certificates: Signed by manufacturers certifying that water softeners comply with requirements.

D.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For water softeners to include in operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Maintenance service agreement.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings from design/build contractor shall indicate size, profiles, and dimensional requirements of water softeners and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

D. ASME Compliance for FRP Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, where indicated.

E. Store salt on raised platform where directed by owner. Do not store in contact with concrete floor.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures of mineral and brine tanks.
    b. Faulty operation of controls.
    c. Deterioration of metals, metal finishes, and other materials beyond normal use.
    d. Attrition loss of resin exceeding 3 percent per year.
    e. Mineral washed out of system during service run or backwashing period.
    f. Effluent turbidity greater and color darker than incoming water.

g. Fouling of underdrain system, gravel, and resin, with turbidity or by dirt, rust, or scale from softener equipment or soft water, while operating according to manufacturer's written operating instructions.

2. Commercial Water Softener, Warranty Period: From date of Substantial Completion.

   a. Mineral Tanks: 10 years.
   b. Brine Tanks: Five years.
   c. Controls: Five years.
   d. Underdrain Systems: Five years.

1.8 MAINTENANCE SERVICE

A. Maintenance: Submit four copies of manufacturer's "Agreement for Continued Service and Maintenance," before Substantial Completion, for Owner's acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing to include replacing materials and equipment. Include one-year term of agreement with option for one-year renewal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL WATER SOFTENERS

A. Description: Factory-assembled, pressure-type water softener.

   1. Manufacturers:

      a. Pacific.
      b. Culligan International Company.
      c. Rainsoft Div.; Aquion Partners L.P.
      d. Prior approved equal.

   2. Comply with NSF 61, "Drinking Water System Components--Health Effects."
   3. Configuration: Twin unit with two mineral tanks and one brine tank.
   4. Mineral Tanks: FRP, pressure-vessel quality.

      a. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section X, "Fiber-Reinforced Plastic Pressure Vessels."

b. Pressure Rating: 125 psig minimum.
c. Wetted Components: Suitable for water temperatures from 40 to at least 150 deg F.
d. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
e. Support Legs or Skirt: Constructed of structural steel, welded to tank.
f. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
g. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers; arranged for even flow distribution through resin bed.
h. Liner: PE, ABS, or other material suitable for potable water.

5. Mineral Tanks: Steel, electric welded; pressure-vessel quality.

a. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
b. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels."
c. Pressure Rating: 150 psig minimum.
d. Wetted Components: Suitable for water temperatures from 40 to at least 150 deg F.
e. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
f. Handholes: 4 inches round or 4 by 6 inches elliptical, in top head and lower sidewall of tanks 30 inches and smaller in diameter.
g. Manhole: 11 by 15 inches in top head of tanks larger than 30 inches in diameter.
h. Support Legs or Skirt: Constructed of structural steel, welded to tank.
i. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication.
j. Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil dry film thickness.
k. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
l. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.
m. Liner: PE, ABS, or other material suitable for potable water.

6. Controls: Fully automatic; factory mounted on unit and factory wired.

a. Adjustable duration of various regeneration steps.
b. Push-button start and complete manual operation.
c. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.

d. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
e. Pointer on pilot-control valve shall indicate cycle of operation.
f. Means of manual operation of pilot-control valve if power fails.
g. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

1) Slow opening and closing, nonslam operation.
2) Diaphragm guiding on full perimeter from fully open to fully closed.
3) Isolated dissimilar metals within valve.
4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
5) Sampling cocks for soft water.
6) Special tools are not required for service.

h. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.

1) Meter Control: Equip each mineral tank with signal-register-head water meter that will produce electrical signal indicating need for regeneration on reaching hand-set total in gallons. Design so signal will continue until reset.
2) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.

7. Brine Tank: Combination measuring and wet-salt storing system.

a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
c. Size: Large enough for at least four regenerations at full salting.

8. Factory-Installed Accessories:

a. Piping, valves, tubing, and drains.
b. Sampling cocks.
c. Main-operating-valve position indicators.
d. Water meters.

B. Capacity and Characteristics:

1. Service: Hot water only.
2. Water Analysis: Design/build contractor shall provide the following values.

a. Hardness: <**Insert grains/gal. or ppm.**>
b. Iron: <**Insert ppm.**>
c. Dissolved Solids: <**Insert ppm.**>
d. Concentration: <**Insert pH.**>
e. Inlet Water Pressure: <**Insert psig.**>
f. Water Temperature: <**Insert deg F.**>

3. Continuous Service Flow Rate: <**Insert number**> gpm at 15-psig pressure drop.
4. Peak Service Flow Rate: <**Insert number**> **gpm at 25-psig** pressure drop.
5. Water Meter Size: <**Insert NPS.**>
6. Manifold Pipe Size: <**Insert NPS.**>
7. Backwash to Drain Pipe Size: <**Insert NPS.**>
8. Water Consumption: <**Insert gal./day.**>
9. Water Demand: <**Insert hours/day.**>
10. Number of Mineral Tanks: Two.
11. Mineral Quantity, Each Tank: <**Insert cu. ft..**>
12. Mineral Exchange Capacity: <**Insert grains/cu. ft. per lb of salt.**>
13. Electrical Characteristics:

    a. Volts: <**Insert value.**>
    b. Phases: <**Insert value.**>
    c. Hertz: <**Insert value.**>
    d. Full-Load Amperes: <**Insert value.**>
    e. Minimum Circuit Ampacity: <**Insert value.**>
    f. Maximum Overcurrent Protection: <**Insert value.**>

14. Salt Capacity: <**Insert lb.**>
15. Minimum Number of Regenerations per Refill: <**Insert number.**>
16. Floor Area Required: <**Insert sq. ft..**>
17. Height Required: <**Insert inches.**>

2.3 CHEMICALS

A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.

1. Exchange Capacity: Insert capacity of calcium carbonate of resin when regenerated with 15 lb of salt.

B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

2.4 WATER TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.5 SOURCE QUALITY CONTROL

A. Hydrostatically test mineral tanks before shipment to minimum of one and one-half times pressure rating.

B. Prepare test reports.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 15 Section "Basic Mechanical Materials and Methods."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevation required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.2 WATER SOFTENER INSTALLATION

A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.

C. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

E. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings shall indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 15 Section "Basic Mechanical Materials and Methods."

D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.

1. Metal general-duty valves are specified in Division 15 Section "Valves."
2. Plastic valves are specified in Division 15 Section "Domestic Water Piping."
3. Exception: Water softeners with factory-installed shutoff valves at locations indicated.

E. Install drains as indirect wastes to spill into open drains or over floor drains.

F. Ground equipment according to Division 16 Section "Grounding and Bonding."

G. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect[**, test, and adjust**] field-assembled components and equipment installation, including connections[**, and to assist in field testing**]. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Add water to brine tanks and fill with salt.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:

1. ASTM D 859, "Test Method for Silica in Water."
2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
3. ASTM D 1068, "Test Methods for Iron in Water."
4. ASTM D 1126, "Test Method for Hardness in Water."
5. ASTM D 1129, "Terminology Relating to Water."
6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water softeners. Refer to Division 1 Section " Demonstration and Training."

END OF SECTION 15469

SECTION 15485 - DOMESTIC HOT WATER GENERATOR STEAM TYPE - SHELL & TUBE

PART 1 - GENERAL

1.1 SCOPE:

A. Provide and install the vertical type packaged semi-instantaneous double walled water heater as scheduled on the drawings.

PART 2 - PRODUCTS

2.1 DESCRIPTION:

A. Heater shall be U-tube, removable tube bundle type. The water shall be heated in the shell and the steam condensed inside the tubes.
B. The heater shall have an integrally mounted non-ferrous recirculating water system to maintain the potable water within +/- 4 degrees F. of the specified outlet temperature under all normal conditions.
C. The closure between hot water bonnet, tube sheet and shell flanges shall be made so either the tube or shell side gasket can be inspected or replace without disturbing the other gasket.

2.2 CONSTRUCTION:

A. The shell shall be constructed of solid austenitic type 316L stainless steel fittings. No copper, stainless or non-metallic shell liners will be acceptable.

B. The tubing shall be double wall copper U-tubes expanded into a solid 304 stainless steel shellside tubesheet and a carbon steel tubeside tubesheet. An open and fully visable 360 degree 3/8" wide leak detection gap shall exist between the two tube sheets. Tubing shall be 3/4" O.D. outer tube and 5/8" O.D. inner tube both of seamless SB 75 or SB111 90/10 copper nickel. The combination metal thickness of the double tube walls shall not be less than .07 inch thickness excluding the leak detection groove depth.

C. In order to provide positive detection and indication of leakage across the exchanger, the common surface between the inner and outer tubes shall be provided with a continuous network of leak detection passages all connected directly to the “tell-tale” space between tube sheets. Design shall provide fully visible 360 degree vented leak detection between tube sheets.“Weep-hole” designs are not acceptable.

D. Unit shall be designed to allow on-site discovery and sealing of leaking tubes without requiring removal of the tube bundle.

2.3 CERTIFICATION:

A. Unit shall be designed, manufactured, and stamped in accordance with Section VIII Div. 1 of ASME Code for design pressures of 150 PSIG at 210 degrees F. shell side and 150 PSIG at 370 degrees F. or 370 PSIG at 450 degrees F. tubeside. ASME

label with national Board registration.

2.4 COMPONENTS:

A. Heater shall have the following completely assembled, ready to be connected at the installation site:

1. Steam control valve with steam piloted, temperature control, factory installed controls package, inlet strainer and down stream vacuum breaker. Provide with discharge water temperature sensor to communicate with central control system. Provide IP transducer for 4-20 mA signal from controls system. Coordinate with controls contractor.
2. Condensate orifice trap.
3. Compound steam pressure liquid filled gage 3-1/2" dial, with syphon and shut off clock.
4. Water pressure temperature relief valve, ASME certified.
5. Water self recirculation system, non-ferrous with 1/12 HP circulator and isolation valves, 115V/60HZ/single phase.
6. Nema 1 panel with on/off switch, green light (normal), red light (high temperature), and high temperautre safety system to shut off hot water flow on pre-selected high temperature setting.
7. Shell insulation: 1-1/2" thick fiber glass type with out 20 gauge stainless steel jacket to comply with ASHRAE 90.1 2001 requirements.
8. Installation, operating and maintenance instructions.
9. Air compressor for valve temperature control. Compressor shall be skid mounted with the unit. Compressor shall be ½ HP, 2 gallon, oil-less compressor that can produce 1.30 cfm at 50 psig. Compressor shall be Thomas Heavy Duty Air-Pac model or prior approved equal.

2.5 PERFORMANCE:

A. Performance shall be as scheduled on the drawings.

2.6 WARRANTY:

A. The heater shall be warranted for one year from the date of start-up against failure due to defects in material or workmanship.

2.7 APPROVED MANUFACTURERS:

A. Ace Boiler Incorporated or equal by.

B. Aerco.

C. Adamson.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in strict accordance with manufacturer's recommendations, 2006 IPC, ANSI/ASHRAE/IESNA 90.1-2004, and all other applicable codes.

END OF SECTION 15485

SECTION 15486 - DOMESTIC HOT WATER GENERATOR STEAM TYPE - PLATE & FRAME

PART 1 - GENERAL

1.1 SCOPE:

A. Provide and install the plate and frame type packaged semi-instantaneous double walled water heater as scheduled on the drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE:

A. Each heater shall be factory assembled with rated performance per drawings.

B. Heater will deliver a constant outlet temperature of ±2-3 °F under stable load conditions.

C. Heater will provide outlet temperatures within ±9 °F of set point when subject to sudden changes in demand.

D. Buffer tank or mixing valve shall not be permitted.

2.2 CONSTRUCTION:

A. Each heater shall have an integrally mounted stainless steel recirculation pump to maintain continuous flow through the heat exchanger.

B. The heat exchanger shall be the bolted plate and frame type so the unit can be serviced without having to disturb <u>any</u> connection on the steam or waterside.

C. Heat exchanger shall have the capacity to be expanded by the addition of plates without removal of the heater from its installed position.

2.3 MATERIALS:

A. All heat transfer surfaces in contact with potable water shall be 316L stainless steel. Copper or non-metallic liners shall not be acceptable.
B. Potable water piping on the package shall be 316L stainless steel.

2.4 CERTIFICATION:

A. System shall be designed, manufactured and stamped in accordance with ASME Section VIII on the primary and secondary side for 150 PSIG @ 350F.

2.5 COMPONENTS:

A. Each packaged water heater shall consist of the following components, which are factory- assembled and ready for connection to services. All steam and

condensate control components must be manufactured and supported by the supplier of the package.

1. Steam Control Valve:
   -*Pneumatic* with single loop PID control and smart positioner.
2. Stainless Steel circulator pump 1/25 HP pre-wired to NEMA 1 control box
3. F&T trap
4. 4" Dial Pressure Gauge
5. Bronze P&T relief Valve set @ 150 psig @ 210°F
6. Carbon steel support stand
7. All other components needed for full operation, and any additional components shown in detail on drawings.
8. Air compressor: 1/2 hp gallon, oil-less compressor for control of pneumatic valve.

2.6 WARRANTY:

A. The heater shall be warranted for one year from date of shipment against failure due to defects in material or workmanship.

2.7 APPROVED MANUFACTURERS:

A. Spirax Sarco

B. Prior Approved Equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in strict accordance with manufacturer's recommendations, 2006 IPC, ANSI/ASHRAE/IESNA 90.1-2004, and all other applicable codes.

END OF SECTION 15485

SECTION 15550 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Listed double-wall vents.

B. Related Sections include the following:

1. Division 15 Section "Draft Control Devices" for induced-draft and mechanical fans and for motorized and barometric dampers.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Type B and BW vents.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 COORDINATION

A. Coordinate installation of roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED TYPE VENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Metal Products; MASCO Corporation.
2. Cleaver-Brooks; Div. of Aqua-Chem Inc.
3. FAMCO.
4. Hart & Cooley, Inc.
5. Heat-Fab, Inc.
6. LSP Products Group, Inc.
7. Metal-Fab, Inc.
8. Schebler Co. (The).

B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B,; with neutral or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch airspace.

D. Inner Shell: ASTM B 209, Type 1100 aluminum ASTM B 209, Type 3003 aluminum ASTM B 209, Type 3105 aluminum.

E. Outer Jacket: Galvanized or Aluminized steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Listed Type B: Vents for certified gas appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

C. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 15550

SECTION 15626 - ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Packaged, air-cooled chillers.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than ARI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Site Altitude: Chiller shall be suitable for Cedar City altitude in which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of chiller.
5. Oil capacity of chiller.
6. Fluid capacity of evaporator.
7. Characteristics of safety relief valves.

B. Operation and Maintenance Data: For each chiller to include in operation, and maintenance manuals.

C. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 and ARI 590 certification programs.

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship chiller from the factory fully charged with refrigerant.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

   a. Complete chiller including refrigerant and oil charge.
   b. Complete compressor and drive assembly including refrigerant and oil charge.
   c. Refrigerantcharge.
   d. Parts and labor.
   e. Loss of refrigerant charge for any reason.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED, AIR-COOLED CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trane; a division of American Standard.
2. Carrier Corporation; a United Technologies company.
3. YORK International Corporation.
4. Prior approved equal.

B. Description: Factory-assembled and run-tested chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Fabricate base, frame, and attachment to chiller components strong enough to resist chiller movement during a seismic event when chiller base is anchored to field support structure.

D. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.
3. Casing: Galvanized steel.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 1000-hour salt-spray test according to ASTM B 117.

5. Sound-reduction package designed to reduce sound level without affecting performance and consisting of the following:

    a. Acoustic enclosure around compressors.
    b. Reduced-speed fans with acoustic treatment.

6. Security Package: Provide removable louvered panels with fasteners for additional protection of compressors, evaporator, and condenser coils without inhibiting service access. Finish to match cabinet.

E. Compressors:

1. Description: Positive displacement, hermetically sealed.
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard one- or two-rotor design.
4. Each compressor provided with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.

F. Service: Easily accessible for inspection and service.

G. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 20 percent of design capacity.
3. For units equipped with a variable frequency controller, capacity control shall be both "valveless" and "stepless," requiring no slide valve or capacity-control valve(s) to operate at reduced capacity.

H. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Factory-installed and pressure-tested piping with isolation valves and accessories.
4. Oil compatible with refrigerant and chiller components.
5. Positive visual indication of oil level.

I. Vibration Control:

1. Vibration Balance: Balance chiller compressors and drive assemblies to provide a precision balance that is free of noticeable vibration over the entire operating range.

    a. Overspeed Test: 25 percent above design operating speed.

2. Isolation: Mount individual compressors on vibration isolators.

J. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, induction type with inherent thermal-overload protection on each phase.

K. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing, or solid state.
2. Variable Frequency Controller:

   a. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
   b. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
   c. Enclosure: Unit mounted, NEMA 250, , with hinged full-front access door with lock and key.
   d. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system.
   e. Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.
   f. Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.

L. Refrigerant Circuits:

1. Refrigerant: As specified by design/build contractor.
2. Refrigerant Type: R-134a R-407c. Classified as Safety Group A1 according to ASHRAE 34.
3. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
4. Refrigerant Circuit: Each shall include a thermal- or electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-corefilter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
5. Pressure Relief Device:

   a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

M. Evaporator:

1. Description: Shell-and-tube design.

a. Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
b. Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.

2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Shell Material: Carbon steel.
4. Shell Heads: Removable carbon-steel heads located at each end of the tube bundle.
5. Fluid Nozzles: Terminated with mechanical-coupling or flanged end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
7. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.
8. Remote Mounting: Designed for remote field mounting where indicated. Provide kit for field installation.

N. Air-Cooled Condenser:

1. Plate-fin coil with integral subcooling on each circuit, rated at 450 psig.

a. Construct coil casing of galvanized steel.
b. Construct coils of copper tubes mechanically bonded to aluminum fins.
c. Coat coils with a baked-epoxy, corrosion-resistant coating after fabrication.
d. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

O. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.
2. House in a unit-mounted, NEMA 250, enclosure with hinged access door with lock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Provide each motor with overcurrent protection.
6. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
7. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.
8. Provide power factor correction capacitors.

9. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

    a. Power unit-mounted controls where indicated.
    b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.

10. Control Relays: Auxiliary and adjustable time-delay relays.
11. For chiller electrical power supply, indicate the following:

    a. Current and phase to phase for all three phases.
    b. Voltage, phase to phase, and phase to neutral for all three phases.
    c. Three-phase real power (kilowatts).
    d. Three-phase reactive power (kilovolt amperes reactive).
    e. Power factor.
    f. Running log of total power versus time (kilowatt-hours).
    g. Fault log, with time and date of each.

P. Controls:

1. Standalone and microprocessor based.
2. Enclosure: Share enclosure with electrical power devices.
3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:

    a. Date and time.
    b. Operating or alarm status.
    c. Operating hours.
    d. Outdoor-air temperature if required for chilled-water reset.
    e. Temperature and pressure of operating set points.
    f. Entering and leaving temperatures of chilled water.
    g. Refrigerant pressures in evaporator and condenser.
    h. Saturation temperature in evaporator and condenser.
    i. No cooling load condition.
    j. Elapsed time meter (compressor run status).
    k. Pump status.
    l. Antirecycling timer status.
    m. Percent of maximum motor amperage.
    n. Current-limit set point.
    o. Number of compressor starts.

4. Control Functions:

    a. Manual or automatic startup and shutdown time schedule.
    b. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Chilled-water leaving temperature shall be reset based on return-water temperature.
    c. Current limit and demand limit.
    d. External chiller emergency stop.

e. Antirecycling timer.
f. Variable evaporator flow.

5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

   a. Low evaporator pressure or high condenser pressure.
   b. Low chilled-water temperature.
   c. Refrigerant high pressure.
   d. High or low oil pressure.
   e. High oil temperature.
   f. Loss of chilled-water flow.
   g. Control device failure.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
7. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
9. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

   a. Hardwired Points:

      1) Monitoring: On-off status, common trouble alarm electrical power demand (kilowatts) electrical power consumption (kilowatt-hours).
      2) Control: On-off operation, chilled-water, discharge temperature set-point adjustment electrical power demand limit.

   b. University Accepted communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

Q. Insulation:

1. Material: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness: 1-1/2 inches.
3. Factory-applied insulation over cold surfaces of chiller components.

   a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

4. Apply protective coating to exposed surfaces of insulation to protect insulation from weather.

R. Accessories:

1. Factory-furnished, chilled-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
3. Factory-furnished neoprene isolators for field installation.
4. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

S. Capacities and Characteristics: Provided by design/build contractor.

1. Capacity: <**Insert tons**>.
2. Full-Load Efficiency (COP): <**Insert value**>.
3. Full-Load Efficiency (EER): <**Insert value**>.
4. Full-Load Efficiency (Power Input/Cooling Output): <**Insert kW/ton**>.
5. Part-Load Efficiency (IPLV): <**Insert value**>.
6. Part-Load Efficiency (NPLV): <**Insert value**>.
7. Low Ambient Operation: Chiller designed for operation to <**Insert temperature**>.
8. High Ambient Operation: Chiller designed for operation to <**Insert temperature**>.
9. Evaporator:

    a. Configuration: [**Integral to chiller**] [**Shipped loose for field installation**].
    b. Pressure Rating: [**150 psig**] [**300 psig**] <**Insert value**>.
    c. Fluid Type: [**Water**] <**Insert fluid type**>.
    d. Design Fluid Flow Rate: <**Insert gpm**>.
    e. Minimum Fluid Flow Rate: <**Insert gpm**>.
    f. Entering-Fluid Temperature: <**Insert deg F**>.
    g. Leaving-Fluid Temperature: <**Insert deg F**>.
    h. Fluid Pressure Drop: <**Insert feet of head**>.
    i. Fluid Velocity: <**Insert fps**>.
    j. Fouling Factor: <**Insert value**>.

10. Condenser Entering-Air Temperature: <**Insert deg F**>.
11. Condenser Fan External Static Pressure: <**Insert wg**>.
12. Site Altitude: <**Insert feet**>.
13. Number of Refrigerant Circuits: <**Insert requirement**>.
14. Compressor:

    a. Number of Compressors: <**Insert number**>.
    b. Rated Load Amperes: <**Insert value**>.
    c. Locked-Rotor Amperes: <**Insert value**>.

15. Control Electrical Requirements:

    a. Power Connection: <**Insert information**>.
    b. Power Input: <**Insert kilowatts**>.
    c. Minimum Circuit Ampacity: <**Insert value**>.
    d. Maximum Overcurrent Protection Device: <**Insert amperage**>.
    e. Volts: [**120**] <**Insert value**>-V ac.

f. Phase: Single.
g. Hertz: 60.

16. Chiller Electrical Requirements:

    a. Power Input: <**Insert kilowatts**>.
    b. Power Factor: <**Insert value**>.
    c. Minimum Circuit Ampacity: <**Insert value**>.
    d. Maximum Overcurrent Protection Device: <**Insert amperage**>.
    e. Volts: <**Insert value**>.
    f. Phase: Three.
    g. Hertz: 60.

17. Noise Rating: <**Insert dBA**> sound power level when measured according to ARI 370. Provide factory-installed sound treatment if necessary to achieve the performance indicated.

2.2 SOURCE QUALITY CONTROL

A. Perform functional tests of chiller before shipping.

B. Factory run test air-cooled chiller with water flowing through evaporator.

C. Factory performance test air-cooled chillers, before shipping, according to ARI 550/590.

1. Test the following conditions:

    a. Design conditions indicated.
    b. Reduction in capacity from design to minimum load in steps of <**Insert number**> with condenser air at design conditions.
    c. At <**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

D. Factory sound test air-cooled chillers, before shipping, according to ARI 370.

1. Test the following conditions:

    a. Design conditions indicated.
    b. Chiller operating at calculated worst-case sound condition.
    c. At <**Insert number**> point(s) of varying part-load performance to be selected by Owner at time of test.

2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

E. Factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. For chillers located outdoors, rate sound power level according to ARI 370.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chiller before installation. Reject chiller that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

A. Install chiller on support structure.

B. Equipment Mounting: Install chiller on concrete base using elastomeric pads. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 1/2 inch.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 15 Section "Hydronic Piping" and Division 15 Section "Refrigerant Piping". Drawings shall indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator

outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.

D. Connect each chiller drain connection with a union and drain pipe. Provide a shutoff valve at each connection.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
9. Verify and record performance of fluid flow and low-temperature interlocks for evaporator.
10. Verify and record performance of chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chiller.

END OF SECTION 15626

SECTION 15710 - HYDRONIC AND STEAM HEAT EXCHANGERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes shell-and-tube heat exchanger.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Operation and Maintenance Data: For heat exchanger to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchanger and are based on the specific equipment indicated. Refer to Division 1 Section "Product Requirements."

B. ASME Compliance: Fabricate and label heat exchanger to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

C. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association's standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers:

1. API Heat Transfer Inc.
2. Armstrong Pumps, Inc.
3. ITT Industries; Bell & Gossett.
4. Taco, Inc.
5. Thrush Company, Inc.
6. Prior approved equal.

B. Configuration: U-tube with removable bundle.

C. Shell Materials: Steel.

D. Head:

1. Materials: Cast iron.
2. Flanged and bolted to shell.

E. Tube:

1. Seamless copper tubes.
2. Tube diameter is determined by manufacturer based on service.

F. Tubesheet Materials: Steel tubesheets.

G. Baffles: Steel.

H. Piping Connections:

1. Shell: 300 # steam flanged inlet and outlet fluid connections, threaded drain, and vent connections.
2. Head: 150 #Flanged hot water inlet and outlet connections.

I. Support Saddles:

1. Fabricated of material similar to shell.
2. Foot mount with provision for anchoring to support.
3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger saddles are anchored to building structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HEAT-EXCHANGER INSTALLATION

A. Install shell-and-tube heat exchangers on saddle supports.

B. Install shell-and-tube heat exchangers on concrete base. Concrete base is specified in Division 15 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

C. Concrete Bases: Anchor heat exchanger to concrete base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections.

B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchanger.

C. Install shutoff valves at heat-exchanger inlet and outlet connections.

D. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

E. Install vacuum breaker at heat-exchanger steam inlet connection.

F. Install hose end valve to drain shell.

3.4 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15710

SECTION 15725 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Constant-air-volume, single-zone air-handling units.
2. Variable-air-volume, single-zone air-handling units.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

   a. Certified fan-performance curves with system operating conditions indicated.
   b. Certified fan-sound power ratings.
   c. Fan construction and accessories.

d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

B. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a member of the United Technologies Corporation Family.
2. Haakon.
3. McQuay International.
4. Scott Springfield Mfg. Inc.
5. Trane; American Standard Inc.
6. YORK International Corporation.
7. Prior approved equal.

2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant.
4. Factory Finish for Steel and Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.

B. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071,.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.

   a. Liner Adhesive: Comply with ASTM C 916, Type I.
   b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.

3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:

   a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:

   a. Hinges: A minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Fabricate windows in doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
   d. Size: At least 24 by 60 inches.

4. Service Light: 100-W vaporproof fixture in each section accessed with door, with switched junction box located inside adjacent to door.

D. Condensate Drain Pans:

1. Fabricated with slopes in at least 2 planes to collect condensate from cooling coils (including coil piping connections, coil headers and return bends, and a minimum of 6 inches downstream from cooling-coil face).
2. A minimum of 2 inches deep, and complying with requirements in ASHRAE 62.1.
3. Drain Connections: Both ends of pan with NPS 1 threaded nipple.
4. Pan-Top Surface Coating: Asphaltic waterproofing compound.
5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 15 Section

"Vibration and Seismic Controls for HVAC Piping and Equipment" when air-handling unit frame is anchored to building structure.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

   a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
4. Flexible Connector: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized-steel sheet or 0.032-inch- thick aluminum sheets; select metal compatible with casing.

   a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

      1) Fabric Minimum Weight: 26 oz./sq. yd..
      2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      3) Fabric Service Temperature: Minus 40 to plus 200 deg F.

C. Plug Fans Housings: Steel cabinet; fabricated without fan scroll and volute housing.

D. Backward-Inclined, Centrifugal Fan Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

F. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

G. Fan Shaft Bearings:

1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 120,000 hours according to ABMA 9.

H. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch-thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

I. Discharge Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and opposed blades constructed of two plates formed around and welded to shaft, with blades linked out of air stream to single control lever.

J. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 2 inches.

1. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.

K. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 16 Sections.
4. Mount unit-mounted disconnect switches on exterior of unit.

2.4 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.
5. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.

2.5 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Filter Gage:

1. 3-1/2-inch- diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 3 percent of full-scale accuracy.
6. Range: 0- to 1.0-inch wg.
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch tubing, and 2- or 3-way vent valves.

2.6 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Comply with requirements in Division 15 Section "HVAC Instrumentation and Controls."

C. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements for HVAC."
    b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
    c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24-V ac.
11. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.
14. Run Time: 12 seconds open, 5 seconds closed.

D. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel or aluminum or extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed or parallel-blade arrangement withsteel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

E. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

F. Combination Filter and Mixing Section:

1. Cabinet support members shall hold 2-inch- thick, pleated, flat, permanent or throwaway filters.
2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.7 CAPACITIES AND CHARACTERISTICS: TBD

2.8 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

D. Steam Coils: Factory tested to 300 psig and to 200 psig underwater according to ARI 410 and ASHRAE 33.

E. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases using restrained spring isolators. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Division 3 Section "." Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 2 inches.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 15 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Steam and Condensate Piping: Comply with applicable requirements in Division 15 Section "Steam and Condensate Piping." Install shutoff valve at steam supply

connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

G. Refrigerant Piping: Comply with applicable requirements in Division 15 Section "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

H. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 15 Section "Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Automatic-Roll-Filter Operational Test: Operate filters to demonstrate compliance with requirements. Test for leakage of unfiltered air while system is operating.
5. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
6. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.
7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 15 Section "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After startup service, clean air-handling units internally on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems, clean filter housings and install new, clean filters.

C. Replace filters immediately prior to occupancy according to the LEED EQ Credit 3.1, "Construction IAQ Management Plan."

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 15725

SECTION 15763 - FAN-COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fan-coil units and accessories.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, configuration operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Operation and Maintenance Data: For fan-coil units to include in operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Compressor failure.
   b. Condenser coil leak.

2. Warranty Period: Five years from date of Substantial Completion.
3. Warranty Period (Compressor Only): Five years from date of Substantial Completion.
4. Warranty Period (Condenser Coil Only): Five years from date of Substantial Completion.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed.
2. Fan Belts: Furnish one spare fan belt for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In the Fan-Coil-Unit Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FAN-COIL UNITS

A. Manufacturers:

1. Airtherm; a Mestek Company.
2. Carrier Corporation.
3. McQuay International.
4. Trane.

5. USA Coil & Air.
6. YORK International Corporation.
7. Prior approved equal.

B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995. Vertical configuration, floor mounted including cabinet, filter, chassis, coil, drain pan, fan an motor in blow through configuration with hydronic cooling and heating coils.

C. Coil Section Insulation: 1-inch thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Main and Auxiliary Drain Pans: Insulated galvanized steel formed to slope from all directions to the drain connection as required by ASHRAE 62..

E. Chassis: Galvanized steel with flanged edges. Floor-mounting units shall have leveling screws.

F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

1. Vertical Unit Front Panels: Removable, steel, with steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.

G. Outdoor-Air Wall Box: Minimum 0.1265-inch- thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.

1. Louver Configuration: Horizontal, rain-resistant louver.
2. Louver Material: Aluminum.
3. Bird Screen: 1/2-inch mesh screen on interior side of louver.
4. Decorative Grille: On outside of intake.
5. Finish: Baked enamel, color as selected by Architect from manufacturer's standard colors.

H. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic, actuators.

I. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.

J. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

K. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 15 Section "Motors."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

L. Control devices and operational sequences are specified in Division 15 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

M. Basic Unit Controls:

1. Control voltage transformer.
2. Wall-mounting thermostat with the following features:

   a. Heat-cool-off switch.
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Exposed indication.
   h. Degree F indication.

3. Outdoor-Air Damper Operation:

   a. Occupied Periods:

      1) Outdoor-Air Temperature below Room Temperature: If room temperature is above thermostat set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below thermostat set point, position damper to fixed minimum position.
      2) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for 25 percent outdoor air.

   b. Unoccupied Periods: Close damper.

N. BAS Interface Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.

   a. Adjust set points.
   b. Fan-coil-unit start, stop, and operating status.
   c. Data inquiry, including outdoor-air damper position, supply- and room-air temperature.
   d. Occupied and unoccupied schedules.

O. Electrical Connection: Factory wire motors and controls for a single electrical connection.

P. Capacities and Characteristics: Provide the following schedule information on the design documents.

1. Fan:

   a. Airflow: <**Insert cfm.**>
   b. External Static Pressure: <**Insert inches wg.**>
   c. Fan Speed: <**Insert rpm.**>
   d. Motor Speed: <**Insert rpm.**>
   e. Motor Horsepower: <**Insert horsepower.**>

2. Cooling Capacity:

   a. Total: <**Insert Btu/h.**>
   b. Sensible: <**Insert Btu/h.**>
   c. Entering-Air Dry-Bulb Temperature: <**Insert deg F.**>
   d. Entering-Air Wet-Bulb Temperature: <**Insert deg F.**>

3. Chilled-Water Coil:

   a. Water Flow: <**Insert gpm.**>
   b. Water-Side Pressure Loss: <**Insert feet wg.**>
   c. Entering-Water Temperature: <**Insert deg F.**>

4. Heating Capacity:

   a. Output: <**Insert Btu/h.**>
   b. Entering-Air Temperature: <**Insert deg F.**>
   c. Air-Temperature Rise: <**Insert deg F.**>

5. Hot-Water Heating Coil:

   a. Water Flow: <**Insert gpm.**>
   b. Water-Side Pressure Loss: <**Insert feet wg.**>
   c. Entering-Water Temperature: <**Insert deg F.**>

6. Filters:

   a. Face Area: <**Insert sq. ft..**>
   b. Thickness: [**1 inch**] [**2 inches**] <**Insert thickness**>.

7. Electrical Characteristics for Single-Point Connection:

   a. Voltage/Phase/Hertz: <**Insert values.**>
   b. Full-Load Amperes: <**Insert value.**>
   c. Maximum Circuit Amperes: <**Insert value.**>
   d. Maximum Overcurrent Protection: <**Insert value.**>

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. If units are suspended provide elastomeric hangers. Vibration isolators for floor mounts are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

D. Coordinate locations of thermostats and any other exposed control sensors with room details before installation. Install devices 48 inches above finished floor.

E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings by the design/build teams shall indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect condensate drain to indirect waste.

    a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

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

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15763

SECTION 15815 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.
3. Division 15 Section “Diffusers, Registers and Grilles.”

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

a. Supply Ducts: 2-inch wg.
b. Return Ducts (Negative Pressure): 1-inch wg.
c. Exhaust Ducts (Negative Pressure): 1-inch wg.

2. Leakage Class:

a. Round Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.
b. Flat-Oval Supply-Air Duct: 3 cfm/100 sq. ft. at 1-inch wg.

c. Rectangular Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.
d. Flexible Supply-Air Duct: 6 cfm/100 sq. ft. at 1-inch wg.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.4 SUBMITTALS

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

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.
4. Fire-stopping material

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

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

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements,

materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

   a. Lindab Inc.
   b. McGill AirFlow LLC.
   c. SEMCO Incorporated.
   d. Sheet Metal Connectors, Inc.
   e. Spiral Manufacturing Co., Inc.
   f. Metco.
   g. Prior approved equal.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter (diameter of the round sides connecting the flat portions of the duct).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 CLOTHES DRYER EXHAUST DUCTWORK

A. Ductwork and dampers shall be aluminum. Interior surfaces shall be smooth. There shall be no obstruction inside the duct, such as metal screws or screens; Joints shall be sealed with a “Tape Sealing System” as specified in this section.

B. Ducts exhausting at the roof shall terminate with an elbow for horizontal discharge. Provide a flapper-type backdraft damper at the terminus.

C. Ducts exhausting through the wall shall terminate with a weather cap and a flapper-type backdraft damper.

D. Ducts shall be installed in accordance with the dryer manufacturer’s instructions and in compliance with the International Mechanical Code.

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.
e. Prior approved equal.
f. Maximum Thermal Conductivity:

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Insulation Pins and Washers:

1. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

   a. Fan discharges.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.

4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

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

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

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

E. Round Duct Joint O-Ring Seals:

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

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2.8 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Mason Industries.
6. Unistrut Corporation; Tyco International, Ltd.
7. Prior approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. The design/build drawings shall include, schematics, and diagrams indicating general location and arrangement of duct system. Indicate duct locations, configurations, and arrangements.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing over or through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 15 Section "Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements," unless otherwise indicated.

1. For static-pressure classes 1- and 1/2-inch wg, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C, except as follows:

a. Ducts that are located directly in zones they serve.

3.3 HANGER AND SUPPORT INSTALLATION

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

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 15 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
2. Test the following systems:

   a. Supply air.
   b. Return air.
   c. Exhaust air.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 15 Section "Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as follows:

1. Clothes dryer vents.

   a. Exposed to View: Aluminum.
   b. Concealed: Aluminum.

2. Moist Environment Ducts: Aluminum.

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate. Dryers only.

C. Liner:

1. Supply- and Return-Air Ducts: Fibrous glass, Type I.

D. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

   a. Velocity 1000 fpm or Lower:

      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.

   b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.

F. Duct Schedule

1. Rectangular duct with liner:

a. Low pressure supply and return.

2. Rectangular duct wrapped with insulation:

a. Low pressure exhaust and fresh air.

3. Single wall round with wrapped insulation.

a. Low pressure supply and return.

END OF SECTION 15815

SECTION 15820 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. High Efficiency Take-Offs.
4. Motorized control dampers.
5. Fire dampers.
6. Ceiling fire dampers.
7. Duct Silencers.
8. Combination fire and smoke dampers.
9. Turning vanes.
10. Duct-mounting access doors.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.

B. Related Sections include the following:

1. Division 15 Section "HVAC Instrumentation and Controls" for electric damper actuators.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. High Efficiency Take-Offs.
4. Motorized control dampers.
5. Fire dampers.
6. Ceiling fire dampers.
7. Duct Silencers.
8. Combination fire and smoke dampers.
9. Turning vanes.
10. Duct-mounting access doors.
11. Flexible connectors.

12. Flexible ducts.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Duro Dyne Corp.
4. Greenheck.
5. Penn Ventilation Company, Inc.
6. Prefco Products, Inc.
7. Ruskin Company.
8. Air Rite.
9. Prior approved equal.

B. Description: Multiple-blade, parallel action gravity balanced, with blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

D. Blades: 0.025-inch- thick, roll-formed aluminum.

E. Blade Seals: Neoprene.

F. Blade Axles: Galvanized steel.

G. Tie Bars and Brackets: Galvanized steel.

H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. METALAIRE, Inc.
4. Nailor Industries Inc.
5. Penn Ventilation Company, Inc.
6. Ruskin Company.
7. Air Rite.
8. Prior approved equal.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

C. Standard Volume Dampers: Opposed-blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Blade Axles: Galvanized steel.
4. Bearings: Oil-impregnated bronze.
5. Tie Bars and Brackets: Galvanized steel.

D. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.5 HIGH EFFICIENCY TAKE-OFF

A. Factory-manufactured rectangular-to-round or round-to-round 45 degree leading tap fabricated of 24 ga zinc-coated lockforming quality steel sheets meeting requirements of ASTM A 653, with G-90 coating.

B. One inch wide mounting flange with die formed corner clips, pre-punched mounting holes, and adhesive coated gasket.

C. Manual Volume Damper:

1. Single blade, 22 ga minimum.
2. 3/8 inch minimum square rod with brass damper bearings at each end.
3. Heavy duty locking quadrant on 1-1/2 inch high stand-off mounting bracket attached to side of round duct.

D. Approved Manufacturers:

1. HETD-L by Daniel Manufacturing.
2. STO by Flexmaster USA Inc.
3. HET by Sheet Metal Connectors Inc.
4. Hercules.
5. Air-Rite.
6. Prior approved equal.

2.6 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Duro Dyne Corp.
4. Greenheck.
5. McGill AirFlow Corporation.
6. METALAIRE, Inc.
7. Nailor Industries Inc.

8. Penn Ventilation Company, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Air Rite.
12. Prior approved equal.

B. General Description: AMCA-rated, opposed-blade design; minimum of 0.1084-inch-thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch-thick, galvanized-steel damper blades with maximum blade width of 8 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Provide closed-cell neoprene edging.

2.7 FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. McGill AirFlow Corporation.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Penn Ventilation Company, Inc.
7. Prefco Products, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.
10. Prior approved equal.

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Fusible Links: Replaceable, 165 deg F rated.

2.8 CEILING FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. McGill AirFlow Corporation.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Penn Ventilation Company, Inc.
7. Prefco Products, Inc.
8. Ruskin Company.
9. Vent Products Company, Inc.
10. Prior approved equal.

B. General Description: Labeled according to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Fusible Links: Replaceable, 165 deg F rated.

2.9 SMOKE AND COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. Nailor Industries Inc.
4. Penn Ventilation Company, Inc.
5. Ruskin Company.
6. Prior approved equal.

B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.

C. Fusible Links: Replaceable, 165 deg F rated.

D. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.

E. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

F. Damper Motors: Modulating and two-position action.

1. Comply with requirements in Division 15 Section "Motors."
2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
4. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
6. Electrical Connection: 115 V, single phase, 60 Hz.

2.10 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Available Manufacturers:

a. Ductmate Industries, Inc.
b. Duro Dyne Corp.
c. METALAIRE, Inc.
d. Prior approved equal.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.11 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:

a. American Warming and Ventilating.
b. Ductmate Industries, Inc.
c. Flexmaster U.S.A., Inc.
d. Greenheck.
e. McGill AirFlow Corporation.
f. Nailor Industries Inc.
g. Ventfabrics, Inc.
h. Ward Industries, Inc.
i. Air Rite.
j. Prior approved equal.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:

a. Less Than 12 Inches Square: Secure with two sash locks.
b. Up to 18 Inches Square: Two hinges and two sash locks.
c. Up to 24 by 48 Inches: Three hinges and two compression latches.
d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

D. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.
3. Ventfabrics, Inc.
4. Prior approved equal.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

2.13 FLEXIBLE DUCTS

A. Manufacturers:

1. Flexmaster U.S.A., Inc.
2. Hart & Cooley, Inc.
3. McGill AirFlow Corporation.
4. Themaflex.
5. Prior approved equal.

B. Insulated-Duct Connectors: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.14 DUCT ACCESSORY HARDWARE

A. 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 of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
4. On sides of ducts where adequate clearance is available.

I. Install the following sizes for duct-mounting, rectangular access doors:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.

J. Install the following sizes for duct-mounting, round access doors:

1. One-Hand or Inspection Access: 8 inches in diameter.
2. Two-Hand Access: 10 inches in diameter.
3. Head and Hand Access: 12 inches in diameter.
4. Head and Shoulders Access: 18 inches in diameter.
5. Body Access: 24 inches in diameter.

K. Label access doors according to Division 15 Section "Mechanical Identification."

L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with draw bands.

O. Install duct test holes as required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION 15820

SECTION 15838 - EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Dampers, including housings, linkages, and operators.
5. Roof curbs.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For power ventilators to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Loren Cook Company ACE-B or equal by
2. Acme Engineering & Mfg. Corp.
3. Breidert Air Products.
4. Carnes Company HVAC.
5. Greenheck.
6. JencoFan; Div. of Breidert Air Products.
7. Penn Ventilation.
8. Prior approved equal.

B. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

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

1. Configuration: Built-in cant and mounting flange.
2. Overall Height: 12 inches.
3. Sound Curb: Curb with sound-absorbing insulation matrix.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Mounting Pedestal: Galvanized steel with removable access panel.
7. Vented Curb: Unlined with louvered vents in vertical sides.

H. Capacities and Characteristics: Provide schedule on design/build drawings.

2.2 MOTORS

A. Comply with requirements in Division 15 Section "Motors."

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings shall indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Verify lubrication for bearings and other moving parts.
7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
8. Shut unit down and reconnect automatic temperature-control operators.
9. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust belt tension.

B. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION 15838

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ceiling diffusers and wall-mounted registers, and grilles.

B. Related Sections include the following:

1. Division 15 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Provide schedule on design/build drawings indicating, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 GRILLES AND REGISTERS

A. Adjustable Bar Side Wall Supply Grille:

1. Products:

a. Carnes; RVEA.

b. Krueger; 5815.
c. METALAIRE, Inc., Metal Industries Inc.; 422.
d. Price Industries; LBMR.
e. Titus; 1707.
f. Tuttle & Bailey; VF5.
g. Or prior approved equal:

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Adjustable horizontal spaced 1/4 inch apart.
5. Frame: 1 inch wide.

B. Fixed Face Ceiling Return, Exhaust, or Transfer Air Grille:

1. Products:

a. Carnes; RSLA.
b. Krueger; S85H.
c. Price Industries; 535.
d. Titus; 355RL.
e. Tuttle & Bailey; T70D.
f. Or prior approved equal:

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2 inch horizontal blade spacing.
5. Frame: 1-1/4 inches wide.

C. Low Sidewall Return Grilles

1. Material: Steel.
2. Finish – Standard white baked enamel.
3. Zero degree deflection.
4. Approved Manufacturers And Models

a. Carnes - RSHA
b. J & J - S-590
c. Krueger - S480H
d. Metalaire - HD-RH
e. Price - 90-L
f. Titus - 30RL or 30 SL
g. Tuttle & Bailey - T110 or equal by
h. Prior approved equal.

2.3 LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

1. Manufacturers:

a. Anemostat; a Mestek Company.
b. Carnes.
c. Krueger.
d. METALAIRE, Inc.; Metal Industries Inc.
e. Nailor Industries of Texas Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
i. Prior approved equal.

2. Material - Shell: Steel, insulated.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked enamel.
5. Finish - Pattern Controller: Baked enamel.
6. Finish - Tees: Baked enamel, white.
7. Slot Width: Indicate on design/build drawings.
8. Number of Slots: Indicate on design/build drawings.

2.4 CEILING DIFFUSER OUTLETS

A. Rectangular and Square Ceiling Diffusers:

1. Products:

a. Carnes; SK-A.
b. Krueger; SH.
c. METALAIRE, Inc., Metal Industries Inc.; 55005.
d. Price Industries; SMD.
e. Titus; TDC.
f. Tuttle & Bailey; MS.
g. Or prior approved equal:

1) A-J Manufacturing Co., Inc.
2) Anemostat; a Mestek Company.
3) Hart & Cooley, Inc.; Hart & Cooley Div.
4) Nailor Industries of Texas Inc.

2. Material: Steel.
3. Finish: Baked enamel, white.

2.5 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Design/build drawings shall indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations shall be located to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. For units installed in lay-in ceiling panels, provide lay-in ceiling module. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

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

END OF SECTION 15855

SECTION 15900 – AUTOMATIC TEMPERATURE CONTROLS

PART – 1 GENERAL

1.1 RELATED DOCUMENTS:

A. The General Conditions, Supplementary General Conditions, alternates and addenda, and the technical specifications, shall apply to all work under this division.

B. The Contractor shall carefully review all notes, coordination schedules, and drawings for work required under this section of the specification.

C. Division –15 General Mechanical Requirement's sections apply to work of this section.

1.2 SCOPE OF WORK:

A. It is intended for the building automation system to be fully networked and installed by a qualified Automatic Temperature Control Contractor. The control system shall consist of electronic type direct digital controllers, input/output module panels, transmission equipment, training, warranty service and accessory equipment for a completely installed system of automatic temperature control.

B. Control sequences are specified in "Sequence of Operation."

C. The ATC Contractor shall furnish and install a complete system of DDC automatic temperature control as specified based on a Tridium/JACE Head End and LonMark/LonWorks Controller Design.

D. The temperature control contractor shall install all necessary electrical control wiring of all temperature controls, heating and ventilating equipment motor starting circuit controls and all electrical control interlocks for same, and for any equipment furnished by the Owner.

E. The Automatic Temperature Control Contractor shall supply and supervise any and or all installation of control valves, water flow switches, temperature well and automatic dampers. Installation of such shall be by Div. 15000 Mechanical Contractor.

F. The temperature control contractor shall allow a minimum of eight (8) hours for system adjustments and fine-tuning of control systems.

1.3 NOT INCLUDED IN SCOPE OF WORK:

A. The electrical contractor shall furnish and install all single phase and multiphase electrical power wiring to magnetic starters, disconnect switches, VFD's, motors and smoke detectors.

B. Division-16 contractor shall be responsible for 120V service to DDC

equipment control panels.

C. The supply and installation of control dampers shall be by Div. 15000 Sheet Metal Contractor. Damper actuators are to be as specified and are the responsibility of the controls contractor for proper sizing and installation.

PART – 2 EXECUTION

2.1 QUALITY ASSURANCE:

A. Acceptable Control Contractors and Control Manufacturers shall be as follows:

1 Invensys Controls as installed by YAMAS as an EXTENTION of the existing campus wide DDC Control System (An existing Invensys I/A Series LonMark/LonWorks Control System & Tridium JACE Router/Network Controller based Head End System).
2 Honeywell is also approved to bid. Pre-Qualifying for other contractors must be submitted and approved at least one week before the bid date. Unqualified or unsolicited bids, as well as, alternate proposals will NOT be excepted. Only bids that comply with the outlined specifications herein will be excepted. Inquiries may be submitted to the Mechanical Engineer for deadlines, clarifications and requirements.

B. Any deviation form this specification shall be brought to the attention of the Mechanical Engineer. It is the responsibility of the contractor to provide an installation that meets the requirements of the specification. Submitting an explanation for deviation from the specification does not any way guarantee that the engineer shall approve the deviation. Due diligence should be followed at all times.

C. Provide unconditional ONE-YEAR parts warranty as part of the overall project warranty.

D. All parts and material used, as well as how they are installed shall be in accordance with the specification as given by the manufacturer. All parts and material shall be new.

E. The Contractor or firm awarded the project work of this section shall have 15 years experience in work of similar scope and nature to that specified. Subcontracting of any part or parts of the project is not admissible, including but not limited to installation and commissioning.

F. The ATC Contractor shall be a branch office of a control manufacturer or an authorized factory representative of a control manufacturer.

G. The ATC Contractor shall have a minimum of ten years operating DDC systems in the geographical area covered by his local organization or branch office.

H. The ATC Contractor shall have a local representative directly employed

by this Contractor that is regularly situated within a 100-mile radius of the project construction site that can respond to management, installation, service and technical issues in person at the construction site.

I. The ATC Contractor shall have in-house and factory qualified Engineering, Programming, Installation, Start-up and Service capability.

2.2 CODES:

A. Comply with NEMA standards pertaining to components and devices for electric control systems.

B. Provide electrical products that have been tested listed and labeled by UL and comply with NEMA standards.

C. Comply with NEMA 90A Standard for the Installation of Air Conditioning and Ventilation Systems where applicable to control sequences and controls.

D. Comply with NEMA 70, all current National Electric Codes, and all state and local laws, and ordinances for all electrical installation.

E. Power wiring (120 VAC or higher) to fans and to all other heating and ventilating equipment including the control panels shall be furnished by the Electrical Contractor. This Contractor is responsible for all control wiring (24 VAC or DC or lower) that is specified in connection with the Automatic Temperature Control System found in this section or elsewhere in other sections or drawings. Any such work or wiring specified in the electrical drawings or other sections as being performed by Div. 16000 electrical contractor shall be excluded from the ATC Contractors scope of work.

F. Temperature control wiring shall be installed in conduit only. State-licensed electricians and apprentices in a planned training program in compliance with state and local regulations and guidelines shall perform all conduit, wiring, and control equipment installations. Only electricians and apprentices Employed Directly by the ATC contractor shall install control equipment and wiring.

G. Wiring in equipment/mechanical rooms shall be in conduit.

2.3 SUBMITTAL AND TECHNICAL INFORMATION

A. Prior to any and or all installation, the Contractor shall submit a complete control system submittal, shop Drawings (7 sets) and manufacturer's data with details of the Automatic Temperature Control and Direct Digital Control Systems. The following items to be accredited to both the facility management operator (maintenance) and the engineer.

B. Complete system control diagrams including electrical and system flow diagrams.

C. Control sequence and material list of each component(s) and its individual description.

D. Complete and detailed sequence of operation including specific reference to points list, flow diagrams, and control valve schematics and sequence.

E. Manufactures specification sheets for each control component selected.

F. Documentation of all software and hardware. These manuals shall be complete with installation procedures as well as start up and programming instructions. They should also contain any testing or maintenance procedures required for operating the system on continuous basis.

G. Complete training schedule to include date(s), time and instructors itinerary.

H. Maintenance manuals shall provide descriptions of maintenance on all system components, including sensors and controlled devices. They shall cover inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components.

I. Other hardware or parts as required.

2.4 OWNER INSTRUCTION UPON COMPLETION OF PROJECT:

A. Upon completion of the project, the temperature control contractor's representative shall spend minimum four (4) hours with the building's operating personnel to instruct them on the operation of the system. See General Provisions, Scope of Work.

B. Upon completion of this project, the temperature control contractor shall provide to the owner’s building operating personnel (Two Persons chosen by the owner) Factory Instruction and Training from Tridium Inc. in a certified course conducted by Tridium Inc in the use and operation of a JACE Router/Network Controller and the associated software. This training shall be provided with any travel, food and lodging associated with facilitating this course necessary for the selected owner personnel to attend. It shall be a standard course not to exceed 40 hours.

C. A letter of completion and acceptance of the Owner shall be delivered to the Owner and Consulting Engineering Firm.

2.5 ELECTRICAL WIRING:

A. All power wiring (120 VAC or higher) to fans and to all other heating and ventilating equipment including the control panels shall be furnished by the Electrical Contractor. This Contractor is responsible for all control wiring (24 VAC or DC or lower) not shown on electrical drawings or specified elsewhere in connection with the Automatic Temperature Control System (ATC). All temperature control wiring shall be installed in conduit. All conduit, wiring, and control equipment installation shall be performed by state licensed

electricians employed directly by the ATC contractor

2.6 GUARANTEE:

A. Components, parts, and assemblies shall be guaranteed against defects in materials and workmanship for a period of two years after acceptance. Expressed warranties are conditionally

based on the requirement that the items covered within the guarantee are used and maintained in accordance with the manufacturer's recommendations.

B. The guarantee commences at the time of project acceptance and continues for the previously indicated duration.

PART – 3 PRODUCTS

3.1 GENERAL

A. The Control System shall be a user programmable, electronic, direct-digital control system. The system shall be designed and manufactured for the purpose of building heating and air conditioning control. The system shall meet all requirements of these specifications. Any deviation form this specification shall be brought to the attention to the Mechanical Engineer in writing including justification for the deviation. If the engineer rejects the deviation from the specification, then the specified controls and/or equipment shall be required. No resubmission will be excepted.

B. Direct Digital Control System - Overview: The direct digital control system shall consist of a local microprocessor-based Java Application Control Engine type Router/Network Controller that will provide Graphic User Interfacing Screens available from a Operator Workstation Computer. The computer shall meet the necessary requirements in order to perform its functions and allow access to the LAN and Internet that the Building Automation System is connected to. The Router/Network Controller shall be connected to a Local Area Ethernet-based Network that is provided exclusively by the owner or other providers. The Router/Network Controller shall be networked, though an industry standard LonTalk Network, to individual Stand-alone LonMark/LonWorks DDC Controllers associated with each piece of equipment specified. It is the intent of these specifications to create a combined direct digital control system. All "system" type control functions, such as those used for fan systems, convertors, chillers, central plant and pumps, building pressurization etc., shall be accomplished by using software algorithms in the respective DDC units. All safety devices such as fire alarm shutdown, smoke detectors, low limit thermostats, etc., shall be hard wired to accomplish their critical functions completely independent of the DDC units and shall have additional outputs as required to serve as inputs to the DDC units for secondary control and reporting functions.

C. Stand-alone Controllers (DDC units): Each controller shall be a

microprocessor and shall form the basic control unit of the system. They shall be completely LonMark/LonWorks compliant. It shall operate as a stand-alone unit providing all the necessary algorithms and software logic to perform the local HVAC control sequences and energy saving functions. Failure of any one DDC units shall have no affect on the other DDC units in the system. Programming shall be accomplished by an optional operator's engineering terminal or via the services of a technician from the Automatic Temperature Control Contractor as optionally contracted. The controller shall consis t of a microprocessor and Input/ Output Modules (I/O) as required by the control application. It shall include a full range of control functions including proportional (P), proportional plus integral (PI), ON/OFF with adjustable switching differential, floating with adjustable dead band, time proportional with adjustable cycle time and maximum time. The controller shall operate independent of any central computer, shall have built-in diagnostic routines, shall allow for custom software programs and allow complete control and logic functions interlock.

D. The DDC units shall utilize EEPROM, allowing changes to programming and data base to be stored in the DDC units, updating all previous programming and erasing all previous data that is no longer needed. Systems utilizing PROM shall not be allowed.

E. The system shall provide a network communication facility to support global control strategies to be implemented in the distributed system. The system shall provide for events detected in any area of the total network. The system shall also provide for connected or calculated data to be continuously shared between any or all controllers within the total network.

F. DDC units shall be capable of being programmed to utilize programmed values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by another DDC units, or by loss of bus communication. Individual application software packages shall also be structured to assume a fail-safe condition upon loss of input sensor. Loss of an input sensor shall result in a Sensor Failed message at the Router/Network Controller and the operator’s terminal. After power failure and upon power restoration, the system shall provide automatic sequential restart of equipment based on current program time and program requirements without operator intervention.

G. Furnish and install all sensors, actuators, transducers, DDC units and central equipment to meet functional description and the I/O summary section as detailed in the plans and specifications.

H. DDC units shall be installed in control panels in each mechanical room and fan room as needed for system functionality. All wiring shall be in accordance with the National Electrical Code and all applicable Local Codes. System components requiring line voltage input shall be designed and tested to operate satisfactorily and without damage at 10% above and 15% below nominal rated voltage.

I. Use of an Optional Portable Operator's Terminal (POT): New DDC controls

and additional DDC managed equipment shall be capable of allowing the use of and access by an optional owner Portable Operator's Terminal to Controllers or Router/Network Controllers connected to the Building Automation System.

J. All programming necessary to perform the required Sequence of Operation as specified shall be included with each stand-alone DDC controller. Testing and verification of performance is to be included. Any changes, additions and deletions to the Sequence of Operation or Programming as originally specified shall be an additional cost to the owner, and shall require prior approval for any deviation or change.

K. Graphic Screens necessary to represent each controlled piece of equipment shall be provided and displayed with set-point adjust, temperatures, on/off status and control, as well as all points necessary to operate the equipment as specified in the sequence of operations from a Screen. These Graphic Screens shall be provided by the Controls Contractor and made available through the use of the Operator Workstation Computer or a remote terminal attached to the Ethernet Network through a Browser.

3.2 ROUTER/NETWORK CONTROLLERS

A. The Controller shall have available built-in services and hardware that will allow integration of LonMark/LonWorks and BACnet Controllers and Networks. Other major protocols, such as Modbus and DDE, as well as other Legacy and propriety based protocol converters, shall be available as options to the Router/Network Controller.

B. Full Internet Web Access features shall be available through a Browser and/or optional use of Engineering Access Software.

C. Communication shall be available through a 10/100 Mbit Ethernet RJ-45 Port Connection.

D. The core software shall utilize a real-time control engine based on a Java Virtual Machine implementation.

E. The Controller shall have a complete set of Java-based control applications, logging, and user interface "objects" included in a library for the Systems Integrator.

F. Global functions, object-oriented graphic screens, scheduling, alarming, simultaneous client workstations, and support for data linking over multiple networks, hosts, and controllers shall be fully supported at the controller.

G. RS-232 and RS-485 Serial ports shall be supported and available.

H. A Drag-and-drop graphical user interface approach shall be used for all standard services and software features. A Java-based Scripting Language, as well as a Compiled Java Language, shall be available for custom

applications and software extensions.

I. The Controller shall have a wall or desktop mountable form factor, and shall be suitable for industrial locations.

J. The Router/Network Controller must be able to be managed by IT Administration through department networks via their administration software tools just as they manage other Windows PC's on their LAN or WAN.

3.3 DDC CONTROLLERS

A. All DDC Controllers shall be LonMark/LonWorks compliant.

B. Complete interoperability will be assured through firmware and hardware that supports all mandatory and optional LonMark Standard Va riables Types (SNVTs) and provides ether a LonMark profile or a LonWorks XID File for each controller.

C. Custom applications shall provide published LonWorks application source code, device resource files and external interface definitions.

D. DDC Controllers shall be based on the Echelon Neuron 3150 microprocessor working integrally with the stand-alone control application program.

E. DDC Controllers, such as application specific, large scale, unitary, or other size and configuration shall be the primary means used to control each defined task or equipment.

F. DDC Controllers shall be programmed from a drag-and drop user interface based programming software tool. Block or object orientation methods for organizing or representing programming shall be employed. No text-based, basic or line interpreted programming languages will be allowed.

G. All DDC Controllers shall be connected and accessible through a LonTalk Network directly interfaced with the Router/Network Controller. No additional converters, gateways, or routers shall be needed to connect the Router/Network Controller to the LonMark/LonWorks compliant DDC Controllers.

H. The installing Contractor shall perform all binding, addressing and configurations of the LonTalk Network and the DDC Controllers on the Network.

I. The LonTalk Network shall operate at 78.8K baud upon an EIA709.1, peer-to-peer, FTT-10 Media and shall be installed using category-4 cabling.

3.4 OPTIONAL OPERATOR WORKSTATION COMPUTERS AND COMPATABLITY

A. No Operator Workstation is required.

B. The owner may submit a change order for additional workstations to add to the Campus wide system. The following specifications are provided to insure compatibility to the existing DDC system:

C. The computer shall be based upon a Pentium IV class microprocessor and the Windows 2000 operating system.

D. It shall have a minimum 17” SVGA color monitor with minimum 16-bit color depth.

E. It shall be equipped with a current industry standard CD-ROM Drive, a 3 ½” Floppy Drive and a Hard Drive all sized for the necessary workstation and application software. It shall be able to accommodate future expansion, upgrade, and additional software.

F. Standard serial, parallel, USB, and Ethernet Ports shall be included.

G. A Microsoft compatible keyboard and mouse shall be supplied and installed on the system.

H. An industry standard sound card, drivers, and speakers will be included with the system.

I. A reliable established Name-brand Company with full service and support available from the manufacturing firm or supplier shall manufacture the computer. Privately assembled computers or third party assemblers will not be acceptable as a manufacturer.

J. A standard full one (1) year warranty on parts and labor shall be provided.

K. All manuals for the computer and the install disks for each software package shall be provided, including manuals.

3.5 DDC INTELLIGENT WALL TEMPERATURE SENSOR/THERMOSTATS

A. DDC Intelligent Wall Sensors shall be integrally incorporated into the DDC architecture of the Controller.

B. They have a contemporary, low profile.

C. It shall have a communication port that allows a portable operator’s terminal to access to the stand-alone controller it is attached to for monitoring of points and changing of key setpoint values.

3.6 SENSING AND CONTROL OUTPUTS REQUIREMENTS

A. Sensing inputs shall be provided via industry standard signals.

B. Temperatures, humidities, differential pressure signals, and all other signal inputs shall be one of the following types:

4-20 mA
0-5 VDC
0-12 VDC

C. Signal inputs shall be compatible with the controllers used, and with the requirement for readout of variables as specified.

D. Modulating outputs shall be industry standard 0-5 VDC, or 0-12 VDC.

E. Milli-amp outputs of 0-20 mA or 4-20 mA are also acceptable.

F. Temperature transmitters shall employ 1000-ohm platinum RTD sensing element with a DIN 43760 standard temperature coefficient. The transmitter shall have an adjustable operating range to allow field adjustment of the range to the specific application. The linearity and hysteresis of the sensor/transmitter system shall not exceed 0.1% of full scale, and the response time shall not exceed 400 microseconds. The transmitter shall have a 4 to 20 ma DC output, and shall operate from a power supply of 12 to 30 volts DC.

3.7 AIR DUCT SMOKE DETECTORS: (by Electrical Division 16000)

A. Smoke detectors shall be furnished and wired by Div. 16000 Electrical Contractor. The electrical contractor shall interlock all Smoke detectors with the building fire alarm system.

B. The air duct fire detector unit shall be listed by Underwriters' laboratories, Inc. The unit shall be designed for detection of combustion gases, fire and smoke in air conditioning and ventilating system ducts in compliance with the National Fire Protection Association Recommended Practices Pamphlet No. 90A. It shall consist of an ionization type detector with a self-contained control unit. The assembly shall consist of a casting to accommodate

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sampling tubes that extend across the duct of the ventilation system. While the fans are operating, flow thru the ionization detector, after which the sampled air shall be returned to the duct. The unit shall provide the following functions:

C. The unit shall operate from a two-wire 120 volt, 60 cycle power source and shall be operable over a range of 102-132 volts. The trouble circuit shall activate if the unit becomes inoperative due to low input voltage. The standby power consumption, excluding any external devices, shall not exceed one watt. The unit shall include power and alarm indicator lights. It shall have a key-operated momentary switch for resetting the unit.

D. Electrical contractor shall provide one set of normally open and one set of single pole double throw alarm operated relay contacts (5A., 120V., AC) at

the building fire alarm panel.

E. ATC Contractor shall mount any and or all such smoke detectors.

3.8 VALVES

A. Automatic valves shall be available in either flanged or screwed connection. Valves 2" and smaller shall be screwed and larger valves shall be flanged. Screwed valves shall be rated at 150 psi and have cast iron, brass or steel bodies. Flanged valves shall be rated at 125-psi minimum and shall have cast iron or steel bodies. All two-way valves normally open or normally closed, shall be furnished with modulating plugs, which produce an equal percentage flow characteristic. Three-way mixing valves shall be furnished with equal percentage plugs.

B. Steam control valves shall be of the globe type and shall utilize a 1/3 and 2/3 arrangement. Hot water and cold water control valves may be of the ball type and the butterfly type.

C. All valves that are furnished for connection to the DDC Control System shall be equipped with electric/electronic actuators.

3.9 DAMPERS AND ACTUATORS

A. Automatic Dampers: The ATC Contractor shall furnish all automatic control dampers that are not furnished as part of the Air Handling Units. The Sheet Metal Contractor shall transition all ductwork to the dampers. All modulating dampers shall be parallel type and the blade width shall not exceed 8 inches. Dampers shall have butyl rubber blade and end seals with adjustable linkage to provide equal percentage characteristics. Linkage to be mounted inside channels of the frame. Bushings to be oil impregnated sintered bronze turning in nylon bearings. Frame of the damper to be drilled by the damper manufacturer to accommodate direct mounting to the damper operators. Leakage to be less than 1% with 2000 FPM and 6" w.g. static across the all dampers submitted shall show data to substantiate above specifications are met. Dampers shall be Ruskin CD50.

B. Damper Actuators: All actuators shall be sized to operate their appropriate dampers with sufficient reserve power to provide smooth action or two-position action as specified. When so specified in the sequence of operation where more than two actuators are to be operated in sequence.

C. Two position actuators shall be electric types. All damper actuators shall be provided with spring return mechanism. Electric damper actuators shall <u>not</u> be of the oil-immersed gear train or rotary type.

D. All damper actuators furnished for connection to the DDC Control System shall be electronic spring return type. Damper actuators for VAV boxes shall be electric or electronic, compatible with the DDC box controller, and shall provide modulating action of the dampers.

PART 4 - SEQUENCE OF OPERATIONS

4.01 CHILLED WATER SYSTEM

A. The DDC System shall enable and disable the Air Cooled Chiller. When enabled the chiller will operate under its factory-supplied controls to maintain the discharge water temperature as reset by the building energy management system.

B. The DDC System shall monitor the Chiller for run status and fault alarm.

C. When the outdoor temperature is above 68 degrees F, the associated lead chilled water pump will start and run continuously whenever there is a call for cooling and in OCCUPIED mode.

D. Each pump is sized for 100% of the system requirements.

E. While under DDC control, a rotation schedule shall be incorporated that provides for scheduled changes of the assigned lead and lag pumps. (Schedule to be determined by School Officials)

F. While under DDC Control, the lag chilled water pump will start and operate if the lead pump fails.

G. The chiller will not start unless at least one of the chilled water pumps is running and a paddle type water flow switch monitored by the DDC System has proved chilled water flow.

F. The DDC System shall monitor both supply and return chilled water temperatures.

4.02 STEAM EXCHANGER AND HOT WATER SYSTEM

A. The heating hot water heat exchanger serves all Fan Coil Units and Air Handling Units.

B. Each pump is sized for 100% of the system requirements.

H. While under DDC control, a rotation schedule shall be incorporated that provides for scheduled changes of the assigned lead and lag pumps. (Schedule to be determined by School Officials)

C. While under DDC Control, the lag hot water, water pump will start and operate if the lead pump fails.

D. The steam to hot water heat exchanger steam valves will be closed if the hot water pumps are off. A temperature sensor, located in the hot water supply of the heat exchanger, through the DDC Controller, will modulate the 1/3 and 2/3 capacity, **normally closed** steam valves in sequence to maintain temperature setpoint as reset by outside air temperature according to the following schedule:

Outdoor Air Hot Water Supply Temperature

Temperature Setpoint
0.0 degrees F. 180.0 degrees F.
70 degrees F. 100.0 degrees F.

E. The temperature will not be reset above 180 degrees.

4.03 CONSTANT VOLUME AIR HANDLING UNITS

A. A separate DDC Control Panel with dedicated controllers shall be supplied for each Fan System.

B. A manual reset low-limit thermostat will be provided and installed on the leaving air side of the hot water coil and upstream of the cooling coil. It will be hard wired to the fan starter and wired in series with fire alarm shutdown wiring. When the setting of the low limit thermostat is exceeded (38.0 degrees F.), the fan will shut down, the outside air dampers will close, and the heating coil valve will open.

C. All fan shutdown functions will operate as described above regardless if the Fan Starter is in “Manual” or “Auto” operation.

D. All fan systems and associated exhaust fans will be commanded off on detection of power failure. After power is restored, the fans will be started again and the air handler re-initialized.

E. The DDC system shall monitor the current-load of the fan through a current switch for each supply fan.

F. Outside air and exhaust air dampers will spring return to their normally closed positions on fan shutdown, power failure and activation of the low limit thermostat.

G. Inputs and outputs required to meet the sequence of operation will be provided, whether or not they are listed in the Input-Output schedule. All points listed in the following I/O Point Schedule will also be provided:

1 Space Air Temperature.
2 Mixed Air Temperature.
3 Return Air Temperature.
4 Discharge Air Temperature.
5 Safety Shutdown Indication.

H. The constant volume air handling unit consists of a mixed air section with outside air, exhaust air and return air dampers, filters, chilled water cooling coil, hot water heating coil, and a supply fan with a combination starter. The unit shall be DDC controlled using electric actuation.

I. Unoccupied Mode: When the AHU is in the unoccupied mode, the supply fan will be off, and the outside and relief air dampers will be closed, and the return air damper will be open. The DDC controller will modulate the hot

water coil valve and the chilled water coil valves in sequence to optimally maintain the space air temperature unoccupied setpoint. The hot water coil valve will open to the coil if the outside air temperature is below 50 degrees F.

J. Night Setback or Morning Warm-up Mode: On a call for night low limit, or morning warm-up operation, the supply fans will operate continuously. The outside and relief air dampers will be closed, and the return air damper will be open. The hot water coil valve will modulate to maintain the maximum heating, discharge air temperature setpoint of 75.0 degrees F. After the space temperatures warm up to occupied settings, the fan system will return to unoccupied or occupied mode, as the case may be.

K. Occupied Mode: During occupied mode, any associated exhaust fans will be interlocked to operate. The DDC controller will modulate the economizer dampers, the hot water coil valve and the chilled water coil valves in sequence to optimally maintain the space air temperature occupied setpoint.

L. Safeties: Safety devices which will shut down the fan system include supply and return fan duct smoke detectors, and hot water coil discharge low temperature limit switch. The building fire alarm will also shutdown the supply fan. The outside and exhaust air dampers will be closed, and the return air damper will be opened. The hot water coil valve will open to the coil. The low temperature safety switch will require manual reset to restart the fan system.

M. Economizer Control: On a call for cooling (room temperature above 74.0 degrees F., adjustable), the outside air damper will modulate open, if the outside air temperature is below the space temperature reading. If the outside air temperature is above the space temperature, the outside air damper will remain at minimum position. If the economizer cannot maintain space-cooling setpoint, the chilled water coil control valve will modulate open to maintain the space temperature. On a call for heating (space temperature below 70.0 degrees F., adjustable), the outside air damper remains at minimum position, and the hot water coil valve will modulate open to maintain the space temperature setpoint.

N. Relief Air Pressure Control: When equipment is equipped with a barometric relief air damper, the Air Handling Unit shall be self-regulating. Where equipment requires a managed relief air damper, a building static pressure transmitter will monitor the building static pressure and report to the DDC System. The Air Handling Unit DDC Controller shall modulate the Relief Air Damper in order to meet the building static pressure setpoint. If the building static pressure falls outside of the parameters set an alarm will be sent to the DDC System.

O. Upon activation of the cooling coil control valve or heating coil control valve, any associated re-circulation pumps shall be started. Upon the closure of the coil control valves, the respective pumps shall be deactivated.

P. Monitoring Points and Fail Safe Control: The DDC controller will monitor the mixed air filter status, with a differential pressure switch. An alarm will

be logged at the host computer on clogged filter alarm.

Q. On a power failure, the outside and exhaust air dampers will spring return to their normally closed position, and the return air damper will spring return to its normally open position.

4.04 EXHAUST FANS

A. Restrooms exhaust fans shall be controlled through the DDC system to operate on an Occupied/Unoccupied schedule. Fan Status shall be monitored by current switch.

B. Common's area exhaust fans shall be controlled with wall mounted switch.

C. Laundry Exhaust Fans shall operate through a manual wall switch and shall be interlocked to the DDC system in order to be disabled during unoccupied mode.

D. The Electric Room exhaust fans shall operate through a wall thermostat in order to maintain the cooling temperature setpoint.

4.05 DORMITORY ROOM FANCOIL UNITS

A. Fan Coil Units consist of a four-pipe hydronic system for heating and cooling, a supply fan, a filter, and factory dampers. These units are equipped with a factory package of controls including valves and actuator. A standard thermostat terminal strip will allow control by a factory supplied programmable wall thermostat.

B. This contractor shall install and wire the programmable thermostat as located on the plans.

END OF SECTION 15900

SECTION 15950 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems: Depending on type of system designed by design/build team.

   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Hydronic Piping Systems: Depending on type of system designed by design/build team.

   a. Constant-flow systems.
   b. Variable-flow systems.
   c. Primary-secondary systems.

3. Steam systems.
4. HVAC equipment quantitative-performance settings.
5. Smoke-control systems testing and adjusting.
6. Verifying that automatic control devices are functioning properly.
7. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

K. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

L. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

M. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

N. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

O. TAB: Testing, adjusting, and balancing.

P. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

Q. Test: A procedure to determine quantitative performance of systems or equipment.

R. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Sample Report Forms: Submit two sets of sample TAB report forms.

C. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

B. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

C. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

D. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

E. Approved TAB agencies:

   1. Bonneville Test and Balance.
   2. BTC Services.
   3. Certified Test and Balance.
   4. Danis Test and Balance.
   5. Intermountain Test and Balance.
   6. RS Analysis.
   7. Technical Specialties.
   8. Testing and Balancing, Inc.
   9. Prior approved equal.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine strainers for clean screens and proper perforations.

M. Examine two and three-way valves for proper installation for their intended function.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine system pumps to ensure absence of entrained air in the suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of all valves and all dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

R. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of

terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance systems similar to constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for

differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check the setting and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record the final setting.

D. Check the settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.12 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure.

E. Check the setting and operation of safety and relief valves. Record settings.

3.13 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.14 PROCEDURES FOR CHILLERS

A. Balance water flow to within specified tolerances of indicated flow with all pumps operating. Do not exceed the flow for the maximum tube velocity recommended by the

chiller manufacturer. Measure and record the following data with chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
3. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
5. Capacity: Calculate in tons of cooling.
6. Verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.15 PROCEDURES FOR BOILERS

A. If hydronic, measure entering- and leaving-water temperatures and water flow.

3.16 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

3.17 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.18 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.19 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.20 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.

5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:

   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Cooling coil static-pressure differential in inches wg.
   g. Heating coil static-pressure differential in inches wg.
   h. Outside airflow in cfm.
   i. Return airflow in cfm.
   j. Outside-air damper position.
   k. Return-air damper position.

G. Apparatus-Coil Test Reports:

1. Coil Data:

   a. System identification.
   b. Location.

c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Inlet steam pressure in psig.

H. Gas- Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btuh.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Low-fire fuel input in Btuh.
b. High-fire fuel input in Btuh.
c. Manifold pressure in psig.
d. High-temperature-limit setting in deg F.

e. Operating set point in Btuh.
f. Motor voltage at each connection.
g. Motor amperage for each phase.
h. Heating value of fuel in Btuh.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.

i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. Packaged Chiller Reports:

1. Unit Data:

a. Unit identification.
b. Make and model number.
c. Manufacturer's serial number.
d. Refrigerant type and capacity in gal..
e. Starter type and size.
f. Starter thermal protection size.
g. Compressor make and model number.
h. Compressor manufacturer's serial number.

2. Air-Cooled Condenser Test Data (Indicated and Actual Values):

a. Refrigerant pressure in psig.
b. Refrigerant temperature in deg F.
c. Entering- and leaving-air temperature in deg F.

3. Evaporator Test Reports (Indicated and Actual Values):

a. Refrigerant pressure in psig.
b. Refrigerant temperature in deg F.

c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.
e. Entering-water pressure in feet of head or psig.
f. Water pressure differential in feet of head or psig.

4. Compressor Test Data (Indicated and Actual Values):

a. Suction pressure in psig.
b. Suction temperature in deg F.
c. Discharge pressure in psig.
d. Discharge temperature in deg F.
e. Oil pressure in psig.
f. Oil temperature in deg F.
g. Voltage at each connection.
h. Amperage for each phase.
i. Kilowatt input.
j. Crankcase heater kilowatt.
k. Chilled-water control set point in deg F.
l. Condenser-water control set point in deg F.
m. Refrigerant low-pressure-cutoff set point in psig.
n. Refrigerant high-pressure-cutoff set point in psig.

5. Refrigerant Test Data (Indicated and Actual Values):

a. Oil level.
b. Refrigerant level.
c. Relief valve setting in psig.
d. Unloader set points in psig.
e. Percentage of cylinders unloaded.
f. Bearing temperatures in deg F.
g. Vane position.
h. Low-temperature-cutoff set point in deg F.

6. Pump Test Data (Indicated and Actual Values):

a. Voltage at each connection.
b. Amperage for each phase.
c. Water flow rate in gpm.

7. Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.
b. Leaving-water temperature in deg F.
c. Water temperature differential in deg F.
d. Entering-water pressure in feet of head or psig.
e. Leaving-water pressure in feet of head or psig.
f. Water pressure differential in feet of head or psig.
g. Water flow rate in gpm.

8. Air Data (Indicated and Actual Values):

a. Duct airflow rate in cfm.
b. Inlet-duct static pressure in inches wg.
c. Outlet-duct static pressure in inches wg.
d. Average entering-air, wet-bulb temperature in deg F.
e. Average leaving-air, wet-bulb temperature in deg F.
f. Ambient wet-bulb temperature in deg F.

M. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.
f. Ratings.

2. Steam Test Data (Indicated and Actual Values):

a. Inlet pressure in psig.
b. Condensate flow rate in lb/h.

3. Primary Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.
b. Leaving-water temperature in deg F.
c. Entering-water pressure in feet of head or psig.
d. Water pressure differential in feet of head or psig.
e. Water flow rate in gpm.

4. Secondary Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.
b. Leaving-water temperature in deg F.
c. Entering-water pressure in feet of head or psig.
d. Water pressure differential in feet of head or psig.
e. Water flow rate in gpm.

N. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in gpm.

g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

O. Boiler Test Reports:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.
f. Fuel type and input in Btuh.
g. Number of passes.
h. Ignition type.
i. Burner-control types.
j. Voltage at each connection.
k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):

a. Operating pressure in psig.
b. Operating temperature in deg F.
c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.
e. Number of safety valves and sizes in NPS.
f. Safety valve settings in psig.
g. High-limit setting in psig.
h. Operating-control setting.

i. High-fire set point.
j. Low-fire set point.
k. Voltage at each connection.
l. Amperage for each phase.
m. Draft fan voltage at each connection.
n. Draft fan amperage for each phase.
o. Manifold pressure in psig.

3.21 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:

   a. Measure airflow of at least 10 percent of air outlets.
   b. Measure water flow of at least 5 percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.22 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 15950

SECTION 16001 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents.

1.2. DESCRIPTION OF WORK: Extent of electrical work is indicated on drawings and/or specified in Division 16 section. Work includes.

ITEM	SECTION
Electrical Connections for Equipment	16070
Conduit Raceways	16110
Raceway Systems	16111
Conductors and Cables	16120
Electrical Boxes and Fittings	16135
Supporting Devices	16136
Wiring Devices	16140
Motor Starters	16155
Variable Frequency Drives	16156
Panelboards	16160
Motor and Circuit Disconnects	16170
Overcurrent Protective Devices	16180
Transformers	16181
Switchgear and Switchboards	16182
Service Entrance	16420
Grounding	16452
Interior and Exterior Building Lighting	16510
Exterior Area Lighting	16551
Lighting Control Equipment	16560
Occupancy Lighting Control and Equipment	16561
Transient Voltage Surge Suppression	16600
Fire Alarm and Detection Systems	16721
Telephone Systems (Raceways)	16740
Television Systems	16780
Access Control System	16782
Clock System	16786
Closed Circuit Television System (CCTV)	16788

1.3. INTERPRETATION OF DRAWINGS AND SPECIFICATIONS: Before bidding, Contractor shall familiarize himself with the drawings, specifications and project site.

1.4. QUALITY ASSURANCE: Comply with requirements of State and Local Ordinances.

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Obtain all permits, inspections, etc. Include all fees in bid. Employ only qualified craftsmen with at least three years of experience. Contractor shall have a current state contractor license.

1.5. SUBMITTALS:

A. SHOP DRAWINGS AND PRODUCT DATA: Prepare complete Shop Drawings and Brochures for materials and equipment. Submit 8 complete sets. Verify all dimensional information.

B. OPERATION AND MAINTENANCE MANUALS: Provide operating instruction and maintenance data books for all equipment and materials. Include complete cleaning and servicing data. Show serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, etc.

1.6. RECORD DRAWINGS:

A. Maintain, on a daily basis.

B. Record dimensions clearly and accurately, delineating the work as installed; identify locations by at least two dimensions to permanent reference points.

C. GUARANTEE: Replace any work or materials which develop defect, within one year.

PART 2 - PRODUCTS

2.1. GENERAL:

A. Products are specified by manufacturer name, description, and/or catalog number.

B. MANUFACTURERS: Provide products of manufacturers specified. Substitutions will be considered if a duplicate written application (2-copies) is submitted.

C. No materials or apparatus may be substituted after the bid opening.

D. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.

2.2. CLEAN:

A. Clean up all equipment, conduit, fittings, packing cartons and other debris.

B. Clean fixtures, interiors and exteriors of all equipment, and raceways.

2.3. POWER OUTAGES:

A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the Owner. Include all costs for overtime work in bid.

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2.4. STORAGE AND PROTECTION OF MATERIALS:

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses.

2.5. EXCAVATING FOR ELECTRICAL WORK:

A. General: Locate and protect existing utilities and other underground work. Perform excavation in a manner which protects walls, footings, and other structural members.

2.6. CONCRETE BASES:

A. Provide 4" high concrete bases for electrical equipment.

2.7. ROOF PENETRATIONS:

A. Provide roof jack, sized to fit thightly to raceway for weathertight seal.

2.8. FIRE PENETRATION SEALS:

A. Seal all penetrations for work of this section through fire rated floors, walls and ceilings.

2.9. PROJECT FINALIZATION AND START-UP:

A. Assemble all equipment Factory Representatives and Subcontractors for system start-up.

B. Give personal instruction on operating and maintenance of their equipment to the Owner's maintenance and/or operation personnel.

2.10. FINAL REVIEW:

A. Project foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels to allow review of the entire electrical system.

END OF SECTION 16001

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SECTION 16070 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1– GENERAL

1.1. DESCRIPTION OF WORK:

A. Includes final electrical connection of all equipment having electrical requirements.

1.2. QUALITY ASSURANCE:

A. NEC Compliance and UL labels required.

PART 2 - PRODUCTS

2.1. GENERAL: Complete assembly of materials, including raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices, terminations, and connections.

A. Permanently installed fixed equipment - flexible seal-tite conduit or raceway; to equipment; all wiring in raceway.

B. Movable and/or portable equipment - wiring device, cord cap, and multi-conductor cord suitable for the equipment.

C. Other methods as required by the National Electrical Code and/or as required by special equipment or field conditions.

PART 3 – EXECUTION

3.1. INSTALLATION OF ELECTRICAL CONNECTIONS:

A. In accordance with connector manufacturer's written instructions and with recognized industry practices.

B. Coordinate with equipment installation work.

C. Verify all electrical loads for equipment furnished under other Divisions.

D. Obtain and review the equipment shop drawings to determine particular final connection requirements.

END OF SECTION 16070

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SECTION 16110 - CONDUIT RACEWAYS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of raceways:

1. Electrical Metallic Tubing
2. Flexible Metal Conduit
3. Intermediate Metal Conduit
4. Liquid-tight Flexible Metal Conduit
5. Rigid Metal Conduit
6. Rigid Non-metallic Conduit

1.2. QUALITY ASSURANCE:

A. MANUFACTURERS: Firms regularly engaged in manufacture raceway systems for not less than three (3) years.

B. STANDARDS: NEMA and NEMA standards, UL safety standards and UL listed and labeled.

PART 2 - PRODUCTS

2.1. METAL CONDUIT AND TUBING:

A. GENERAL: Metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".

PART 3 - EXECUTION

3.1. INSTALLATION OF ELECTRICAL RACEWAYS:

A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and in accordance with the following.

B. SERVICE ENTRANCE CONDUCTORS: Install in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct, individually encased in concrete.

C. FEEDERS UNDER 600 VOLTS: Install feeders to panels and motor control centers and individual equipment feeders rated 100 amps and greater, in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct. Encase feeders 1-1/4" and larger, individually in concrete where installed below slab-on-grade, or below grade. See duct banks.

D. BRANCH CIRCUITS, SIGNAL AND CONTROL CIRCUITS, AND INDIVIDUAL

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EQUIPMENT CIRCUITS RATED LESS THAN 100 AMPS: Install in electric metallic tubing (EMT); except in poured walls, below concrete slab-on-grade, or in earth fill, install in non-metallic plastic duct. Encase non-metallic duct 1-1/4" and larger in concrete. See duct banks.

E. Provide expansion fittings on all conduits crossing buildings expansion joints.

F. DUCTBANKS: Provide ductbank construction as indicated using 3000 psi concrete with red marker dye. Install #4 reinforcing bar in each corner of ductbank. Provide minimum 4" concrete cover on all sides of exterior conduits.

END OF SECTION 16110

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SECTION 16111 - RACEWAY SYSTEMS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Extent of raceways is indicated by drawings and schedules.

B. Types of raceways in this section include the following:

1. Cable Tray Systems

1.2. QUALITY ASSURANCE:

A. STANDARDS: Comply with applicable portions of NEMA NEC and UL.

PART 2 - PRODUCTS

2.1. MANUFACTURED RACEWAY SYSTEMS:

A. GENERAL: Provide complete assembly of raceway including, all components and accessories as needed for complete system.

B. CABLE TRAY SYSTEMS: Provide tray systems of sizes, types and capacities indicated; NEMA Class III, 12" wide ladder type with 4" side rails and 6" rung spacing.

PART 3 - EXECUTION

3.1. INSTALLATION OF ELECTRICAL RACEWAYS:

A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and complying with recognized industry practices.

END OF SECTION 16111

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SECTION 16120 - CONDUCTORS AND CABLES (MEDIUM AND LOW VOLTAGE)

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of conductors and cables in this section include the following:

1. Copper Conductors (600V)
2. Copper Conductor (15KV)

B. Applications for conductors and cables required for project include:

1. Power Distribution
2. Feeders
3. Branch Circuits

PART 2 - PRODUCTS

2.1. COPPER CONDUCTORS (600V):

A. Distribution and Panelboard Feeders; and Other Conductors, #2 AWG and Larger - Copper conductor.

B. Branch Circuit Conductors and A11 Conductors #3 AWG and Smaller - Copper conductor, with THHN/THWN insulation. Size all conductors in accordance with NEC; minimum size to be #12 AWG. Provide stranded conductors for #8 AWG and larger.

C. Provide #10 AWG neutral conductor for all three and four wire fluorescent circuit home runs.

2.2. COPPER CONDUCTORS (15V):

A. GENERAL: Provide 1/c type MV90, copper, 133 percent level, ethylene propylene insulated, shielded, jacketed power cable. Provide cable suitable for installation in underground ducts.

B. CONDUCTOR: Construct with Class B stranding, concentric or compressed round, soft annealed copper.

C. INSULATION: Use extruded, semicon, thermoset, EPR compound.

D. CONDUCTOR SCREEN: Provide extruded layer of semiconducting EPR thermosetting compound.

E. INSULATION SHIELDING: Construct shielding utilizing 5 mil copper tape applied with a minimum 12-1/2 percent overlap.

F. JACKET: Construct of PVC where used in underground ducts.

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G. MANUFACTURER: Subject to compliance with requirements, provide products of one of the following:

1. Cablec
2. Okonite Co.
3. Kerite

2.3. SPLICES AND TERMINATIONS

A. All high voltage splices and terminations will be done by the University Electrical Shop. Include cost in bid.

PART 3 - EXECUTION

3.1. INSTALLATION:

A. General: Install electric conductors and cables as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.

END OF SECTION 16120

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SECTION 16135 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of electrical boxes and fittings in this section include the following:

Outlet Boxes	Miscellaneous Boxes and Fittings
Knockout closures	Locknuts
Junction Boxes	Bushings
Pull Boxes	Conduit Bodies
Floor Boxes	

1.2. QUALITY ASSURANCE:

A. Comply with NEC AND ANSI. Provide UL label.

PART 2 - PRODUCTS

2.1. FABRICATED MATERIALS:

A. INTERIOR OUTLET BOXES: One piece, galvanized flat rolled sheet steel minimum depth 1-1/4".

B. WEATHERPROOF OUTLET BOXES: Corrosion-resistant cast-metal weatherproof outlet wiring boxes.

C. JUNCTION AND PULL BOXES: Code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation;equipped with stainless steel nuts, bolts, screws and washers.

D. FLOOR BOXES: Cast-iron waterproof adjustable floor boxes.

E. CONDUIT BODIES: Galvanized cast-metal conduit bodies, of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

F. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS: Corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushings and offset connectors.

PART 3 - EXECUTION

3.1. INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. GENERAL: Comply with recognized industry practices. Provide coverplates for all boxes, weatherproof outlets for locations exposed to moisture, knockout closures to cap unused knockout holes, and install to ensure accessiblity. Fasten boxes rigidly to substarters or embed in concrete or masonry.

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END OF SECTION 16135

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SECTION 16136 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK: Include supports, anchors, sleeves and seals required for raceway support system.

1.2. QUALITY ASSURANCE: Comply with NEC. Provide UL label.

PART 2 - PRODUCTS:

2.1. SUPPORTING DEVICES

A. Complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation.

PART 3 - EXECUTION

3.1. INSTALLATION OF SUPPORTING DEVICES:

A. Install in accordance with manufacturer's instructions and with recognized industry practices.

3.2. RACEWAYS: Support raceways in accordance with the following:

NUMBER OF RUNS	3/4" TO 1-1/4"	1-1/2" & LARGER 0
1	Full straps, clamps	Hanger or hangers.
2	Full straps, clamps	Mounting Channel or hangers.
3 or more	Mounting Channel	Mounting Channel

A. Do not use "tie wire". Do not support raceway from ceiling support wires.

3.3. FLOOR MOUNTED EQUIPMENT: Provide rigid attachment of all floor slab or strucutural system.

3.4. CABLE TRAYS: Provide vertical and lateral support systems.

END OF SECTION 16136

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SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types include:

1. Receptacles
2. Switches
3. Dimmer controls
4. Cord caps
5. Cord connectors
6. Floor service outlets

1.2. QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards. UL listing and label.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

PART 2 - PRODUCTS

2.1. FABRICATED WIRING DEVICES:

A. Provide wiring devices of proper voltage rating. Manufacturer as specified.

B. Provide hospital grade devices and tamper proof devices where indicated.

C. GROUND-FAULT INTERRUPTER: Provide general-duty, duplex receptacle, ground-fault circuit interrupters.

D. CORD CAPS AND CONNECTORS: Provide 3-wire grounding, cap plugs, and connectors of ampere and voltage rating required.

E. INCANDESCENT LAMP DIMMERS: Provide branch lighting solid-state AC dimmer controls for incandescent fixtures; wattage and voltage as indicated.

F. FLUORESCENT LAMP DIMMERS: Single-pole, semi-conductor modular type AC dimmers for fluorescent fixtures; continuously adjustable slider control, and with electromagnetic filters to reduce noise and interference to minimum.

2.2. WIRING DEVICE ACCESSORIES:

A. WALL PLATES: Plate color to match wiring devices, nylon coverplates in all finished areas.

B. FLOOR SERVICE OUTLETS: Leveling and fully adjustable with finish as

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selected by Architect.

C. POKE-THROUGH ASSEMBLY DEVICES: Factory-assembled poke-through assembly devices equipped with wiring devices.

D. TELEPHONE/POWER POLES: Factory-assembled telephone/power poles for use with telephone and power systems installed above suspended ceilings.

PART 3 - EXECUTION

3.1. Comply with manufacturer's instructions and recognized industry practices.

3.2. TESTING: Test for continuity and proper polarity connections.

END OF SECTION 16140

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SECTION 16155 - MOTOR STARTERS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of motor starters in this section includes:

1. AC Fraction Horsepower Manual Starters
2. AC Line Voltage Manual Starters
3. AC Non-Reversing Magnetic Starters
4. AC Combination Non-Reversing Magnetic Starters

1.2. QUALITY ASSURANCE:

A. Comply with NEC and NEMA. Provide UL-listing and label.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned drawings.

C. MOTOR VOLTAGE/CURRENT REPORT: After installation is complete, measure voltage of each phase of each motor.

PART 2 - PRODUCTS

2.1. MANUFACTURER: As specified.

2.2. MAINTENANCE STOCK, FUSES: Furnish spare fuses.

2.3. MOTOR STARTERS:

A. GENERAL: Provide motor starters and ancillary components; of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials.

B. THERMAL OVERLOAD UNITS: Provide thermal overload units, sized to actual running full load current.

C. AC FRACTIONAL HP MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510):

D. AC LINE VOLTAGE MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510):

E. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8539):

F. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO

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SQUARE D CLASS 8538):

PART 3 - EXECUTION

3.1. INSTALLATION OF MOTOR STARTERS:

A. Comply with manufacturer's written instructions, recognized industry practices.

3.2. POWER FACTOR CORRECTION:

A. Provide individual capacitors for each motor rated 10HP or more,selected to improve power factor to a minimum of 95%. Connect at motor terminals.

3.3. ADJUST AND CLEAN:

A. Inspect operating mechanisms. Adjust units.

3.4. FIELD QUALITY CONTROL:

A. Energize and demonstrate functioning.

END OF SECTION 16155

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SECTION 16156 - VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of variable frequency drive (VFD) work as shown by drawings, schedules and shown herein. Work includes complete installation, electrical connections, testing, and commissioning.

1.2 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and IEEE. Comply with applicable requirements of UL 508, "Power Conversion Equipment".

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. GENERAL: Subject to compliance with requirements, provide products manufactured by one of the following:

Allen Bradley; Mitsubishi; ABB; GE/Fuji or approved equal.

2.2 GENERAL:

A. Provide pulse width modulated variable frequency A.C. drives and ancillary components; of types, sizes, ratings and electrical characteristics indicated which comply with manufacturer's standard materials, design and construction in accordance with published information and as required for a complete installation.

2.3 VARIABLE FREQUENCY DRIVE SYSTEM:

A. The variable frequency AC drive shall convert 3 phase, 60 Hertz input power to an adjustable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The rectifier section (converter) shall employ a diode or fully gated bridge to develop a constant DC bus voltage. Variable voltage rectifiers utilizing partially gated SCR's are unacceptable. The DC bus shall utilize filter capacitors and DC link inductors to minimize generated harmonics. The PWM inverter control scheme shall produce an output wave form which closely approximates actual sine wave current.

PART 3 – EXECUTION

3.1 INSTALLATION OF VARIABLE FREQUENCY DRIVES:

A. Install variable frequency drives as shown, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

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3.2 START-UP SERVICES:

A. The supplier of the AC drive described herein, shall provide field start-up service by an authorized factory trained service representative. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as shown herein. Start-up service shall include system check-out, start-up and system run, and harmonic testing.

END OF SECTION 16156

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SECTION 16160 - PANELBOARDS

PART 1 – GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of panelboards and enclosures in this section include lighting and appliance panelboards.

1.2. QUALITY ASSURANCE:

A. Provide UL listing. Comply with NEC and NEMA Stds. Pub No. 250, and Pub No. 1.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer data.

B. SHOP DRAWINGS: Submit dimensioned drawings of panelboards and enclosures.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS: As specified.

2.2. PANELBOARDS:

A. POWER DISTRIBUTION PANELBOARDS: Dead-front safety type. Equip with copper bus bars, full-sized neutral bus and ground bus.

B. LIGHTING AND APPLIANCE PANELBOARDS: Dead-front safety. Provide bolt-on thermal magnetic type branch breakers. Equip with copper bus bars, full-sized neutral bus, and ground bus.

PART 3 - EXECUTION

3.1. INSTALLATION OF PANELBOARDS:

A. GENERAL: Install in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation".

END OF SECTION 16160

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SECTION 16170 - MOTOR AND CIRCUIT DISCONNECTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Complete installation and electrical connections.

1.2. QUALITY ASSURANCE:

A. Comply with NEMA Standards and NEC. Provide UL listing.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data including specifications, installation and general recommendations.

B. SHOP DRAWINGS: Submit dimensioned drawings of switches which have rating of 100 amperes and larger.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS:

A. MANUFACTURER: As specified.

2.2. FABRICATED SWITCHES:

A. GENERAL: Provide:

1. General duty switches on 240 Volt rated circuits.
2. Heavy duty switches on 480 volt rated circuits.
3. HP rated switches on all motor circuits.

2.3. FUSES: Provide fuses for switches. Provide spare fuses.

PART 3 - EXECUTION

3.1. INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES:

A. Install switches where indicated, complying with manufacturer's written instructions, requirements of NEC, NEMA, and NECA's "Standard of Installation" and in accordance with recognized industry practices.

B. Coordinate with electrical raceway and cable work.

END OF SECTION 16170

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SECTION 16180 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of overcurrent protective devices include:

1. Molded case circuit breakers
2. Power circuit breakers
3. Fusible switches
4. Molded case systems breakers
5. Bolted pressure switches
6. Fuses

1.2. QUALITY ASSURANCE:

A. Comply with NEC NEMA and ANSI standards.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit layout drawings.

C. MAINTENANCE STOCK, FUSES: Funish spare fuses.

PART 2 - PRODUCTS

2.1. MOLDED CASE CIRCUIT BREAKERS: Provide breakers with permanent thermal trip and adjustable instantaneous magnetic trip in each pole.

2.2. FUSIBLE SWITCHES: Provide fusible switch units with quick-break, quick break mechanisms, visible blades and dual horpsepower ratings. Equip with lockable handles. Provide with Class R rejection fuse clip kits.

2.3. BOLTED PRESSURE SWITCHES: Equip switches with electric capacitor operated trip and Buss KAZ signal activating fuses open. Provide "blown fuse protection" in HPC switches.

2.4. PHASE FAILURE PROTECTION: Provide on overcurrent protective devices as indicated.

2.5. GROUND FAULT PROTECTION: Provide on all overcurrent protective devices where phase to ground voltage is in excess of 150 volts and the overcurrent protection device is capable of being set at or over 1000 amps.

PART 3 - EXECUTION

3.1. INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

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

B. Comply with NEC and NEMA standards.

C. Set field-adjustable circuit breakers for trip settings as indicated.

D. Field test all ground fault devices.

3.2. FIELD QUALITY CONTROL:

A. Test devices for continuity of circuitry and for short-circuits.

END OF SECTION 16180

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SECTION 16181 - TRANSFORMERS

PART 1– GENERAL

1.1. DESCRIPTION OF WORK:

A. Types of transformers include the following:

1. Liquid-Filled transformers
2. Dry-type transformer

1.2. QUALITY ASSURANCE:

A. Comply with NEC as applicable portions of NEMA Std. Pub. Nos. TR1 and TR27; and with ANSI/IEEE standards.

B. Comply with ANSI/UL 506. Provide Ul listing.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned drawings.

PART 2 -PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS: As specified.

2.2. OIL-FILLED DISTRIBUTION TRANSFORMERS: Factory-assembled, liquid-filled outdoor type tamper resistant, pad mounted distribution transformers where shown; of sizes, and characteristics, as indicated; 3-phase 60-hertz.

PART 3 - EXECUTION

3.1. INSTALLATION OF TRANSFORMERS:

A. Comply with manufacturer's instructions, requirements of NEC, NEMA and IEEE standards.

B. TESTING: Energize test.

END OF SECTION 16181

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SECTION 16182 - SWITCHGEAR AND SWITCHBOARDS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS:

A. AC Dead Front Switchboards (600V)
B. Metal Enclosed Interrupter Switchgear (15KV)
C. Fault Interrupting Oil Switches (15KV)(Type IFLDR)

1.2. QUALITY ASSURANCE:

A. Comply with NEC, NEMA, ANSI and IEEE. Provide UL-listing and label.

1.3. SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data.

B. SHOP DRAWINGS: Submit dimensioned drawings.

C. MAINTENANCE STOCK FUSES: Furnish stock fuses.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS: As specified.

2.2. AC DEAD FRONT SWITCHBOARDS (600V):

A. Factory assembled, dead front, metal enclosed, group mounted, secondary power switch boards, of ratings and characteristics indicated; consisting of panel (vertical) units, and containing circuit breaker and fusible switch assemblies. Provide copper main bus.

2.3. METAL ENCLOSED INTERRUPTER SWITCHGEAR, (15KV CLASS):

A. Factory assembled dead front metal enclosed NEMA Class 2 primary switchgear rating and characteristics indicated.

B. Provide current limiting fuses.

C. Provide meters, instruments and relays that are isolated from the high voltage equipment by a grounded steel barrier.

2.4. FAULT INTERRUPTING OIL SWITCHES (IFLDR) (15KV):

A. Provide G&W type IFLDR, fused load break oil switches, rated 15KV, fused as shown, 200 amp continuous and load break, and close and latch with a current limiting fuse in series.

B. Equip switch with quick-matke, quick-break operating mechanims. Provide

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silver-sand, current limiting type fuses, suitable for immersing in oil.

PART 3– EXECUTION

3.1. INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS:

A. Comply with manufacturer's written instructions, and recognized industry practices.

3.2. ADJUST AND CLEAN:

A. Adjust operating mechanisms.

3.3. FIELD QUALITY CONTROL:

A. Test switchgear and switchboards for electrical continuity of circuits, and for short circuits.

END OF SECTION 16182

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SECTION 16788 - CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 – GENERAL

1.1 CONDITIONS AND REQUIREMENTS:

A. Refer to General Conditions, Supplemental General Conditions, Special Conditions, and Division 1 General Requirements and all other Divisions and Sections related to the security requirements, conditions, equipment and provisions.

B. Specific manufacturer name(s) and model number(s) are used to establish a level of quality and a specific set of operational functions.

1.2 DESCRIPTION OF WORK:

A. Provide a complete and operating 100% solid-state, color video system complete with cameras, monitors, protective enclosures, lenses, mounting hardware, cables, switching equipment and other such products, equipment and wiring normally and reasonably required for the operation of a complete video surveillance and digital recording system.

B. Equipment shall conform to the requirements of FCC and EIA rules and regulations including EIA standard RS-170A covering color television equipment.

C. These systems include interfacing and interconnection with other low voltage systems described in this specification. Verify the requirements for these interfaces and provide auxiliary equipment necessary for complete functioning of all systems.

D. Provision of conduit, raceways, shelves and backboards is not included under this section of the work but the security subcontractor shall closely coordinate installation of these.

1.3 SUBMITTALS:

A. PRODUCT DATA: Submit manufacturer's data on closed circuit TV and recording systems including, but not limited to, roughing-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals. Also include standard or typical riser and complete wiring diagrams for controls and system components.

B. SHOP DRAWINGS: Provide shop drawings showing equipment/device locations and connecting wiring of entire CCTV system. Include wiring diagrams and riser diagrams.

PART 2 – PRODUCTS

2.1 EQUIPMENT:

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A. All CCTV equipment shall be as manufactured by one of the following, contingent upon meeting the plans and specifications.

Philips	Nice
Pelco	Loronix
Vicon	Sensormatic

2.2 EXTERIOR PRE-PACKAGED CAMERA DOME HOUSING ASSEMBLY WITH PAN-TILT-ZOOM:

A. The camera system shall be a variable/high-speed, domed camera system consisting of an integral 1/4-inch, high resolution, CCD camera with an integral 360° pan/tilt and integral receiver/driver.

2.3 DOME PAN-TILT-ZOOM CONTROLLER:

A. The controller shall be compatible with facilities pan-tilt-zoom cameras.

B. The controller shall allow up to 8 Receiver/Drivers to be connected in a daisy chain configuration.

2.4 INTERIOR PRE-PACKAGED FIXED CAMERA/LENS/DOME HOUSING ASSEMBLY:

A. The camera/lens/housing shall include a high resolution color camera. The unit shall be capable of mounting in suspended gyp board or lay-in ceiling.

2.5 EXTERIOR PRE-PACKAGED FIXED CAMERA/LENS/DOME HOUSING ASSEMBLY:

A. The camera/lens/housing shall include a fixed high-resolution color camera.

2.6 DIGITAL VIDEO RECORDING SYSTEM

A. 16 Input Digital Video Recording System: The digital video management system design shall be a microprocessor-based video processor, multiplexer and recorder running on the Windows 2000 operating system. Designed to operate with black-and-white and color composite video signals, the device shall compress and multiplex video images from up to 16 cameras and store them in the unit's image database.

2.7 128 CAMERA MICROPROCESSOR BASED VIDEO SWITCHER/CONTROL SYSTEM

A. The product described in this specification shall be a Bosch LTC 8600 Series Allegiant® switcher/control system. This system can switch up to 128 camera inputs to 16 monitor outputs. The system also provides biphase control code output used to control Bosch cameras and other Bosch switcher/control system accessories.

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2.8 VIDEO MULTIPLEXER, SIXTEEN INPUT, COLOR, DUPLEX

A. The video multiplexer shall consist of a time-base corrected multi-camera recording and playback device, multi-camera display generator, activity detector, switcher, Coaxitron controller, all combined into a single self-contained unit.

2.9 DIGITAL QUAD VIDEO PROCESSOR

A. The digital quad video processor shall be a color/black-white video processor capable of displaying full-screen or quad views of four camera inputs and real-time quad video. The digital quad video processor shall have four camera inputs with four looping outputs, quad monitor output that displays continuous four-camera image, and call monitor output that displays full-screen or quad image.

2.10 19” LCD COMPUTER SCREEN

PART 3 – EXECUTION

3.1 INSTALLATION:

A. Security video camera and monitor interconnections shall be made.

B. Coaxial video and signal cable shall be installed in metallic conduits and shall be continuous from outlet to outlet without splices. Termination of cables shall be at equipment locations only. Install coaxial cable without sharp bends and terminate only with connectors.

C. Special care in cable installation shall be exercised to avoid grounds due to careless terminations or damage to the jacket over the shield. Take special care to ensure that random contact of shields of adjacent cables do not occur in consoles and at junction boxes.

D. Exterior units shall be mounted for optimum coverage and shall protect camera from accidental blows and vandalism. Provide all required mounting hardware.

3.2 TRAINING:

A. The Contractor shall include in the base contract all costs required to train the Owner operating and maintenance personnel in the use and maintenance of systems provided under this division of the specifications. Instructors certified in writing, by the manufacturer of the specific system, shall conduct the training sessions. Provide a minimum of 6 hours or training to be divided into three training sessions. Training sessions are to be videotape. The videotapes are to be turned over to the owner with the O&M Manuals.

3.3 WARRANTY:

A. Provide a one year parts and on site labor warranty. This does not include abuse, mishandling or acts of nature.

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END OF SECTION 16788

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