SECTION 019100 - COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commissioning objectives and scope.
2. Definitions of commissioning team members.
3. Definitions of commissioning terminology.
4. Description of the commissioning process.
5. Sample Commissioning Master Equipment and Systems Log.
6. Sample PC/FT checklists.
7. Commissioning Certificate of Completion.

B. Related Sections:

1. 017900 - Demonstration and Training
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200529 - Mechanical Hangers and Supports
5. 200548 - Mechanical Vibration and Seismic Control
6. 200553 - Mechanical Identification
7. 200556 - Interior Trench Excavation and Backfill
8. 200700 - Mechanical Insulation
9. 211000 - Water Based Fire Suppression Systems
10. 213000 - Fire Pumps
11. 221100 - Domestic Water Piping and Specialties
12. 221300 - Sanitary Waste and Vent Piping and Specialties
13. 224000 - Plumbing Fixtures

14. 230593 - Testing, Adjusting and Balancing
15. 231113 - Fuel Oil Piping and Specialties
16. 231323 - Aboveground Fuel Oil Storage Tanks
17. 232113 - Hydronic Piping and Specialties
18. 232123 - Hydronic Pumps
19. 233100 - Ducts and Accessories
20. 233400 - HVAC Fans
21. 233600 - Air Terminal Units
22. 233700 - Air Outlets and Inlets
23. 235100 - Breechings, Chimneys and Stacks
24. 235223 - Cast Iron Boilers and Accessories
25. 236400 - Packaged Water Chillers
26. 237323 - Central Air Handling Units
27. 238123 - Dedicated Air-Conditioning Units
28. 238200 - Terminal Heating and Cooling Units
29. 238316 - Radiant Floor Heating Equipment
30. 253000 - Building Automation System Field Devices
31. 254000 - Variable Speed Drives
32. 255000 - Building Automation System
33. 259000 - Sequence of Operations
34. 260000 - Electrical General Requirements
35. 260519 - Low Voltage Electrical Power Conductors and Cables
36. 260526 - Grounding and Bonding for Electrical Systems
37. 260529 - Hangers and Supports for Electrical Systems
38. 260533 - Raceway and Boxes for Electrical Systems
39. 260553 - Identification for Electrical Systems

40. 260943 - Network Lighting Controls (nLight)
41. 262200 - Low Voltage Transformers
42. 262416 - Panelboards
43. 262726 - Wiring Devices
44. 262800 - Low Voltage Circuit Protective Devices
45. 262816 - Enclosed Switches and Circuit Breakers
46. 262900 - Low Voltage Controllers
47. 262916 - Enclosed Contactors
48. 263213 - Diesel Engine Driven Generator Sets
49. 263623 - Automatic Transfer Switches (ATS)
50. 264300 - Surge Protective Devices
51. 265000 - Lighting Fixtures
52. 270536 - Cable Trays for Electrical Systems
53. 272010 - Telecom Distribution System
54. 272020 - Telecom Optical Fiber Distribution
55. 28 1333 - Security Management System
56. 282310 - IP Closed Circuit Television System
57. 283100 - Addressable Fire Alarm System

1.2 RELATED DOCUMENTS

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

1.3 REFERENCES

A. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) HVAC Systems Commissioning Manual.

B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

1. Standard 202-2013 - Commissioning Process for Buildings and Systems.

2. Guideline 0-2005 - The Commissioning Process.

3. Guideline 1.1 - 2007 - The HVAC Commissioning Process.

C. American Society for Healthcare Engineering (ASHE) Health Facility Commissioning Guidelines.

1.4 SCOPE

A. Provide commissioning for the systems, subsystems, and equipment as identified in Divisions 20, 21, 22, 23, 25, 26, 27, and 28 using the commissioning process outlined by this section.

B. Complete the following commissioning objectives to the satisfaction of the Commissioning Authority:

1. Furnish, install, adjust, operate, and test systems, subsystems, and equipment to meet the design intent of the Contract Documents, applicable Code, and manufacturer's installation instructions.

2. Document the installation, starting, and testing of the systems, subsystems, and equipment.

3. Provide complete and annotated installation, operation, and maintenance manuals, and red line drawings which accurately reflect the actual installed systems, subsystems, and equipment configurations. Updates to incorporate changes due to commissioning process.

4. Provide complete project record documents which accurately reflect the actual installation of systems, sub systems and equipment.

5. Formally train the Contracting Agency's maintenance staff such that they are made familiar with the operation and maintenance requirements of the systems, subsystems and equipment through effective training.

6. Document the maintenance staff training.

7. Coordinate the commissioning process with all parties involved in the project in order to maintain project schedule, documentation, and quality control.

8. Coordinate with contractors, sub-contractors, and equipment manufacturer's authorized representative, to provide the appropriate field and office support for commissioning activities, including but not limited to, the following anticipated support:

a. Building Automation System sub-contractor shall provide support for obtaining trend BAS data and information as requested by the CA or Contracting Agency.
b. Building Automation System sub-contractor shall provide field support for commissioning activities during the CA's verification site visit.
c. Mechanical and electrical contractors and sub-contractors shall provide field support for commissioning activities during the CA's verification site visit.
d. TAB contractor shall provide field support for commissioning activities, including spot-checking of TAB report values and verification of room pressure relationships during the CA's verification site visit.

e. Equipment manufacturer's authorized representative for start-up and adjustment.

9. Verify that the project BAS and other systems operation and maintenance manual accurately documents the final sequences of operation programming and equipment/sensor "tuned" setpoint adjustments.

10. Complete commissioning activities including items identified by CA and Contracting Agency during FC prior to project closeout.

1.5 DEFINITIONS

A. Commissioning Authority (CA): The person(s) or company responsible, on the Contracting Agency's behalf, for verifying that the commissioning process is properly executed and completed in accordance with the Contract Documents. The CA reviews and approves the scope, planning, scheduling, execution, documentation, training and final completion of the overall commissioning process. The CA works directly for the Contracting Agency's Project Manager.

B. Contractor's Commissioning Representative (CCR): The Contractor's representative is responsible for planning, scheduling, managing, executing and documenting the required commissioning activities. The CCR must be experienced in basic design, operation, installation and testing of HVAC and electrical systems and must have strong administrative, planning, organizational and communication skills. The primary duty of the CCR is to oversee the commissioning process. The CA and the Contracting Agency approves the selection of the CCR. The Contractor shall have the CCR removed and replaced with an approved replacement at any time during the contract without additional cost or project duration, at the request of the Contracting Agency.

C. Contractors Commissioning Team: Members of the Contractor's team responsible for commissioning activities. These team members include, but are not limited to:

1. The CCR and designated support staff.

2. Mechanical and electrical coordinators.

3. Subcontractors.

4. Sub-subcontractors.

5. Product and System Vendors.

6. Manufacturer's Representatives.

D. Commissioning Master Equipment and System Log: A tabulated list of equipment and systems that are required to be commissioned as identified in Divisions 20, 21, 22, 23, 25, 26, 27 and 28 of the specifications. A sample log is provided in Part 3 of this section.

E. Pre-Functional Installation Checklist (PC): A list of equipment inspections and elementary component tests required for verification of proper installation of equipment. Pre-functional checklist items include static inspections and procedures to prepare the equipment or system for

initial operation (e.g., supports, hangers, and seismic restraint installed, belt tension, fluid levels, labels and tags affixed, sensors and gages correctly located and calibrated, etc.) and simple testing of component or system function, (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). Pre-functional checklists augment and are combined with the manufacturer's start-up checklist. The CCR field verifies that the pre-functional checks are completed and processed. The Contracting Agency and CA may elect to witness the execution of selected parts of the PC.

F. Functional Performance Test Checklist (FC): A list of performance tests required to document the proper performance of the dynamic function and operation of equipment and systems using direct observation and monitoring equipment methods. The CCR and the Contracting Agency field verify that the FTs take place. The CA will witness the execution of selected parts of the FT. The Contracting Agency may elect to witness the execution of selected parts of the FT. The CCR field verifies that the functional performance test checklists are completed and processed

G. Functional Performance Test (FT): Systematic testing of the dynamic function and operation of equipment and systems using direct observation and monitoring equipment methods. Functional testing includes dynamic testing of systems under full operation, including interaction with related systems (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through the control system's sequences of operation and components are verified to be responding as stated in the sequences. Functional Performance Tests are performed after PCs, equipment startups, and Testing, Adjusting and Balancing (TAB) are complete. The CCR field verifies that the functional performance tests are completed and processed. The Contracting Agency and CA may elect to witness the execution of selected parts of the FT.

H. Deferred Functional Tests: FTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed at an earlier date. Only those functional tests pre-approved by the Contracting Agency and the CA may be deferred.

I. Functional Completion: Completion of the commissioning activities required by the Contract Documents prior to Substantial Completion, as defined in the Project Manual.

J. Phased Commissioning: Commissioning that is completed in pre-approved phases (by floors or areas, for example) due to the size of the systems or other scheduling issues, in order minimize total construction time.

K. Commissioning Final Verification: CA site observation of systems after completion of all PC, FC, and FT. Upon satisfactory system demonstration, the CA will sign-off the applicable FC.

1.6 COMMISSIONING PROCESS

A. Commissioning Master Equipment and System Log:

1. Within 30 days after receipt of conformed documents, the CA will provide the Commissioning Master Equipment and System Log to the CCR.

2. The CCR may advise the CA regarding any proposed reorganization and/or reformatting of the Commissioning Master Equipment and System Log to support construction.

B. Construction Schedule:

1. The CCR shall incorporate the items from the Commissioning Master Equipment and System Log into the Construction Schedule.

2. Commissioning final verification to be observed by the CA shall be scheduled in advance and such that multiple systems or pieces of equipment can be observed during each site visit.

3. Use of Phased Commissioning shall be pre-approved by the CA and Contracting Agency.

C. Schedule of Values:

1. The CCR shall incorporate the tasks from the Commissioning Master Equipment and System Log into the Schedule of Values.

D. Commissioning Meetings:

1. The CCR shall plan, schedule, coordinate, and conduct the commissioning meetings. The CCR shall record, maintain, and distribute the minutes for each meeting. The CA will review and approve meeting minutes.

2. Within 60 days after award of the Contract, hold an initial commissioning meeting at the job site. All members of the commissioning team shall be present at the meeting. The purpose of the meeting is to:

a. Identify the commissioning team members and provide contact information.
b. Provide an overview of the commissioning process.
c. Discuss administrative requirements, responsibilities and scheduling.
d. Discuss the status of the Commissioning Master Equipment and System Log.

3. After IO&Ms are submitted and approved, and prior to the start of commissioning, hold a pre-commissioning meeting. All members of the commissioning team shall be present at the meeting either in person or by teleconference. The purpose of the meeting is to:

a. Review Master Equipment and System Log: CA will provide updated Master Equipment and Systems Log, PCs, and FCs for review and comment by the commissioning team.
b. Present the Commissioning Schedule: CCR will provide updated commissioning schedule for review and comment by the commissioning team.

4. Hold a regularly scheduled commissioning status meeting every month. The CA and the Contracting Agency will be present in person or via teleconference at each meeting. Additional members of the commissioning team shall attend these meetings as directed by the CCR.

E. Installation, Operation and Maintenance Data:

1. The CCR shall oversee the preparation of product installation, operation, and maintenance data. Installation, operation and maintenance data shall be submitted to the Contracting Agency within 30 days of approval of submittals.

2. Neatly annotate installation, operation, and maintenance data to identify information relevant to the approved product. Strike out superfluous information. Installation, operation, and maintenance data that is not annotated and contains information for multiple products or variations of a product will be returned to the contractor for resubmittal without production of a checklist.

3. The Contracting Agency will approve the installation, operation and maintenance data and checklists for conformance to the design intent.

4. The CA will provide final approval for installation, operation and maintenance data and associated checklists for completeness and suitability for the purpose of supporting commissioning activities.

5. See 017823 - Operation and Maintenance Data.

F. Checklists:

1. Upon final approval of fully annotated installation, operation, and maintenance data, the CA shall prepare pre-functional installation examination checklist and functional performance test checklists.

2. CA shall complete checklists and deliver them to the CCR within 90 days of receiving fully annotated installation, operation, and maintenance data.

3. The CCR may advise the CA regarding any proposed modifications to the checklists to support construction and the Contract Documents.

4. The CCR may request that specific system or equipment checklists be expedited to no less than 30 days from the date of the request.

G. Commissioning Binders:

1. The CCR shall maintain the master copy of the approved installation, operation and maintenance data, test reports, and checklists. Neatly arrange and label the data by specification section in the commissioning binders. Include a copy of the Commissioning Master Equipment and System Log at the front of the binders. Annotate this log to accurately reflect the status of completeness.

2. The Contracting Agency or CA will periodically review the master commissioning binders. Prior to each monthly meeting or site visit by the CA, the CCR will transmit electronic

scans of commissioning checklists; these scans shall be transmitted to the CA and the Contracting Agency.

3. The CCR will transmit the updated Commissioning Master Equipment and System Log to the CA and Contracting Agency once each week.

4. The CCR will maintain a second copy of the approved installation, operation and maintenance data, test reports, and the checklists. This copy will serve as the formal O&M manual submittal to the Contracting Agency.

H. Equipment Installation:

1. The CCR provides written approval prior to the start of installation for each item listed on the Commissioning Master Equipment and System Log. Equipment shall not be installed unless approved installation, operation and maintenance data, and PC and FC forms are on file in the master commissioning binders.

2. The CCR updates the Construction Schedule to indicate actual installation start date.

3. The installer obtains a copy of the installation information and PC from the CCR. The equipment is installed using a copy of the approved installation instructions and the associated PC.

4. The installer signs off each step of the PC and submits the completed PC to the subcontractor responsible for the work.

5. The subcontractor reviews the PC, physically verifies that the equipment is properly installed and signs the subcontractor review block of the PC.

6. The CCR reviews the PC provided by the subcontractor, observes the work and signs the CCR review block.

7. The CCR files the completed PC in the commissioning binder and signs off the Commissioning Master Equipment and System Log to indicate the equipment is installed.

8. The CCR updates the Construction Schedule to indicate that the equipment installation is complete.

9. The CCR forwards an electronic (PDF) copy of the completed PC to the CA.

10. The CA files the PC in the CA's copy of the commissioning binders.

I. Training Materials:

1. Upon approval of installation, operation and maintenance data and checklists, the CCR shall oversee the formulation of training topics and associated syllabi and training material to support the items on the Commissioning Master Equipment and System Log.

2. The Contracting Agency will approve training topics for conformance to the design intent.

3. The CA will provide final approval of training topics for suitability to support commissioning.

4. The CCR shall maintain the master copy of the training syllabi and training material. Neatly arrange and label by specification section and/or system the information in the training binders. Provide a table of contents which lists the training topics and current status of training material approval. The CA will periodically review the master training binders. This master training binder will serve as the formal training documentation submittal to the Contracting Agency.

5. The CCR shall update the Construction Schedule to indicate status of training material approval.

J. Functional Performance Testing:

1. The CCR provides written approval prior to the start of functional testing for each item listed on the Commissioning Master Equipment and System Log. Functional testing of equipment is not allowed unless the approved PC has been completed and is on file in the master commissioning binder.

2. The CCR updates the Construction Schedule to indicate the actual functional testing start date.

3. The contractor's functional equipment tester obtains a copy of the approved installation, operation, and maintenance data and FC from the CCR.

4. The equipment or system is functionally tested using a copy of the approved installation, operation and maintenance data and FC.

5. The functional tester signs off each step of the FC and forwards the completed FC form to the applicable subcontractor responsible for the work.

6. The subcontractor reviews the FC, physically verifies proper equipment operation with the operator and signs the subcontractor review block of the FC and informs the CCR that the equipment FC is complete, and the equipment is ready for final checkout.

7. The CCR informs the CA when a group of systems or equipment is ready for final checkout and requests a date and time for a site visit by the CA for final checkout (14 days minimum notification time is required).

8. The CA will request a minimum of four days of trend data for the systems and equipment to be tested a minimum of five days prior to final checkout. The CA will provide a list of points to be trended and the format for submitting trend data.

9. The CA will notify the Contracting Agency and arrangements will be made to include maintenance staff personnel at final equipment checkouts as much as possible to support effective field training.

10. During final checkout, the Contractor will be allowed to correct, and retest deficiencies found, at the CA's discretion and if the issue will take less than ten minutes to correct. If corrections take longer than ten minutes or if excessive failures are found on single pieces

of equipment or system, the CA will document the testing as a failure and the Contractor will be required to correct the issue(s) for testing at a later date.

11. If similar deficiencies are found in 10 percent of the systems and equipment tested during final checkout, the CA will stop testing of that type of system or equipment and document the failure typical of all. This includes TAB contractor spot-checking of TAB report values. Minimum of three similar deficiencies to be found prior to CA stopping testing.

12. If a piece of equipment or system fails final checkout during the CA's site visit an additional site visit is required to document satisfactory completion of the final checkout. The additional site visit, including travel, per diem, expenses, and CA's labor, will be at the Contractor's expense.

13. Upon satisfactory completion of the final checkout, the CCR and CA shall sign appropriate review blocks of the FC.

14. The CCR files the completed FC in the commissioning binder and signs off the Commissioning Master Equipment and System Log to indicate that equipment functional tests for that item are complete.

15. The CCR updates the Construction Schedule to indicate that the equipment functional testing is complete.

K. Training:

1. Upon approval of training topics and training material and the actual installation status of equipment, the CCR shall review and modify the construction schedule as necessary to maintain an up-to-date training schedule. Training shall not be given on a piece of equipment until functional testing for the equipment is satisfactory completed and the completed FC is on record in the commissioning binder.

2. The CA will review and approve the training schedule.

3. The CCR shall issue a training notice two weeks prior to the scheduled training session. Disseminate the notice via e-mail, fax or other method as approved by the CA.

4. Include the following information in the notice:

   a. Training topic.
   b. Instructor name and contact telephone number and e-mail address.
   c. Date, time, location, duration.

5. The CCR shall monitor the training topics, verify that the training occurs and effectively covers all training topics indicated on the syllabi.

6. The CCR shall verify that a written training record is completed for each topic which includes the following:

   a. Training topic.
   b. Date and time of training.
   c. Instructor name, title and contact information.

d. Attendance list.
e. Signature of instructor indicating that each item identified in the syllabi was effectively covered during the training session.
f. CCR signature indicating that the training was effective.

7. The CCR shall forward a copy of the completed training report to the CA for review and approval.

8. The CA will approve and file the completed training record.

9. Instruction shall include:

a. Unique or special features or intricacies of system operation.
b. Service frequency of devices such as bearings, belt drives, filters, strainers, etc.
c. Proper maintenance and cleaning procedures.
d. Safety features.
e. Hazards to be aware of.
f. Precautions to be observed to avoid damage to equipment.
g. Seasonal adjustments required.
h. BAS interface for monitoring and controlling equipment and system.
i. Where additional information can be found in the Operating and Maintenance Manuals.

10. See Section 017900 - Demonstration and Training for additional training requirements.

L. Record Drawings:

1. The CCR shall oversee the maintenance of master “as-built” mark-ups of the Contract Documents as the work progresses. To accurately reflect actual installation conditions, document addendum items, field changes, and installation modifications on the “as-built” mark-ups. Update the master “as-built” mark-ups a minimum of once a week.

2. The Contracting Agency will review the “as-built” mark-ups during each site visit and provide a specific comment on each field report indicating the status of “as-built” drawings with regard to completeness and design intent.

3. Upon completion of construction, the “as-built” drawings shall be drafted using AutoCad to produce the project Record Drawings.

4. The CCR shall verify that the completed Record Drawings accurately reflect the constructed project and forward to the CA for final approval full size paper copies and electronic PDF and AutoCAD files.

5. The CA will review the Record Drawings for final approval.

6. See 017839 - Project Record Documents for additional record document requirements.

1.7 SUBMITTALS

A. Contractor's Commissioning Representative (CCR):

1. Submit qualifications of the general contractor's proposed CCR.

a. Previous experience as CCR on similar healthcare projects.
b. Three owner references as CCR for their projects.

B. Commissioning Reports:

1. CCR to submit a written commissioning report which documents the findings of the preliminary walk-through. Include a punch list of discrepancies, corrective actions required and estimated complete date.

2. CCR to submit a second written report which confirms that the preliminary walk-through discrepancies have been satisfactorily corrected.

3. CCR to submit a written commissioning report which documents the field commissioning, training and project documentation effort oversight of the testing, adjusting and balancing effort, the review of installation, operation and maintenance manuals have been completed.

C. Commissioning Certificate:

1. Submit the complete commissioning certificate provided at the end of this specification section.

2. Persons signing the certificate must be in responsible charge for the portion of work completed and signing authority for the firm indicated.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 COMMISSIONING MASTER EQUIPMENT AND SYSTEMS LOG (SAMPLE)

A. The following sample Commissioning Master Equipment and Systems Log is provided to show general format only and does not include all the equipment, systems, and subsystems to be commissioned. Refer to Divisions 20, 21, 22, 23, 25, 26, 27, and 28 for specific systems, subsystems, and equipment to be commissioned.

3.2 COMMISSIONING MASTER EQUIPMENT AND SYSTEMS LIST

PRODUCTS	System/Equipment Tag	System/Equipment Description	Equipment Submittal Approved	I/O&M Approved	PC and FT Checklists Approved	Training Syllabus Approved	PC Completed	FT Completed	Training Completed
Divisions 20, 21, 22, 23, 25 - Mechanical									
1	BLR-1 thru BLR-2	Central Heating Plant							
2	PMP-1 thru PMP-12 AS-1/ET-1/2	Central Heating System							
3	HX-1 ET-3/GM-1 PMP-19/20	Secondary Glycol Heating Loop Penthouse 3001							
4	PMP-27 ET-15	Heat Recovery Loop AHU-2							
5	HX-2 ET-6/GM-3 PMP-28/29	Secondary Glycol Heating Loop Penthouse 3101							
6	PMP-36 ET-16	Heat Recovery Loop AHU-4							
7	CH-1	Central Cooling Plant							
8	PMP-21 thru PMP-24 ET-4/GM-2 BT-1	Central Cooling System							
9	PMP-38/39 PMP-40/ 41/42	Radiant Floor Heating System							
10	HX-4 ET-9/GM-5 PMP-15/16 PMP-17/18	Snow-Melt System							
11	AHU/RFU-1	Central Ventilation System							
12	AHU/EFU-2	Central Ventilation System							

PRODUCTS	System/Equipment Tag	System/Equipment Description	Equipment Submittal Approved	I/O&M Approved	PC and FT Checklists Approved	Training Syllabus Approved	PC Completed	FT Completed	Training Completed
13	AHU/RFU-3	Central Ventilation System							
14	AHU/EFU-4	Central Ventilation System							
15	SCF-1	Boiler Room 1189 Ventilation							
16	SCF-2	Penthouse 3001 Ventilation							
17	WH-1/ET-11 PMP-13/44	Water Heating System (Domestic)							
18	FP-1/JP-1	Fire Pump							
19	PMP-48	Elevator Sump Pump							
20	VAV-101 thru VAV-135	VAV Terminals AHU-1							
21	VAV-201 thru VAV-209	VAV Terminals AHU-2							
22	VAV-301 thru VAV-343	VAV Terminals AHU-3							
23	VAV-401 thru VAV-420	VAV Terminals AHU-4							
24	EAV-1 thru EAV-38	Exhaust Air Valves EFU-2							
25	UH-1 thru UH-20	Unit Heaters							
26	CUH-1 thru CUH-6	Cabinet Unit Heaters							
27	RP-1 thru RP-7C	Radiant Panels							
28	FT-1 thru FT-5	Fin Tube							

PRODUCTS	System/Equipment Tag	System/Equipment Description	Equipment Submittal Approved	I/O&M Approved	PC and FT Checklists Approved	Training Syllabus Approved	PC Completed	FT Completed	Training Completed
29	ACU-1/2/3 - DC-1 PMP-25/26 ET-5	Air-Conditioning System (Telecom)							
Divisions 26, 27 and 28 - Electrical									
30	WC	Wire and Cable (Megger Test Feeder Cables)							
31	ATS-S	Auto Transfer Switch - Standby							
32	ATS-E	Auto Transfer Switch - Emergency							
33	DS	Distribution Switchboards							
34	GS	Grounding Systems – Power/Telecom							
35	ST	Secondary Transformers							
36	SP	Switchboards and Panel boards							
37	TVSS	Transient Voltage Surge Suppression							
38	OPD	Over current Protective Devices							
39	MS	Motor Starters							
40	LF	Lighting Fixtures							
41	LC	Lighting Control Systems							
42	FA	Fire Alarm System							
43	CRWS	Computer Raceway and Wiring Systems							
44	SA	Security Alarm							

PRODUCTS	System/Equipment Tag	System/Equipment Description	Equipment Submittal Approved	I/O&M Approved	PC and FT Checklists Approved	Training Syllabus Approved	PC Completed	FT Completed	Training Completed
45	CCTV	CCTV							
46	PM	Power Monitoring							
47	AV	Audio/Video Systems							
48	PA	PA System							

3.3 COMMISSIONING PRE-FUCTIONAL INSTALLATION (PC) AND FUNCTIONAL PERFORMANCE TEST (FT) CHECKLISTS (SAMPLES)

A. The following sample commissioning checklists are provide to show general format only and do not include all the equipment and systems to be commissioned. Refer to Division 11, Divisions 20, 21, 22, 23, 25, and Divisions 26, 27 and 28 for specific systems, subsystems and equipment to be commissioned.

Pre-Functional Installation Checklist (PC)
Air Handling Unit

PROJECT:	Yakutat Community Health Clinic	UNIT NO:	_____
LOCATION:	_____Yakutat, AK_____	SERVICE:	_____
MANUFACTURER:	_____	MODEL:	_____

ITEM	OK	COMMENT
PRE-START-UP INSPECTION		
Mountings Checked (Shipping Bolts Removed)		
Vibration Isolators Installed		
Seismic Restraints Installed		
Equipment Guards Installed		
Pulleys Aligned and Belt Tension Correct		
Plenums Clear and Free of Loose Material		
Fans Rotate Freely		
Fans, Motors and Linkages Lubricated		
Fire & Balance Dampers Positioned		
Temporary Start-up Filters Installed		
Electrical Connections Completed		
Disconnect Switch Installed		
Overload Heaters in Place (Sized Correctly)		
Heating Coil Clean and Clear – Piping Complete		
Cooling Coil Clean and Clear – Piping Complete		
Condensate Drains Clear		
Humidifier Section Installation Completed		
Safety Controls Operational		
Building & Fan Room Clean For Start-up		
Duct Cleaning Completed		
Control System Completed (End to End Checks)		

COMMENTS:_____
_____
_____

Review (Foreman):	_____	DATE:	_____
Review (CCR):	_____	DATE:	_____
Approved (CA):	_____	DATE:	_____

Functional Performance Checklist (FT)
Air Handling Unit

PROJECT:	Yakutat Community Health Clinic	UNIT NO:	_____
LOCATION:	_____Yakutat, AK_____	SERVICE:	_____
MANUFACTURER:	_____	MODEL:	_____

ITEM	OK	COMMENT
START-UP INSPECTION		
Start-up By Manufacturer's Representative		
Fan Rotation Correct		
Electrical Interlocks Verified		
Fan Status Indicators Verified (Local / Remote)		
Freeze Protection Operational		
Local Air Leakage Acceptable		
Vibration & Noise Level Acceptable		
Motor Amps – Rated _____Actual _____		
Motor Volts – Rated _____Actual _____		
Final Operating Filters Installed		

COMMENTS:

_____

_____

_____

Functional Testing By:	_____	DATE:	_____
Review (Foreman):	_____	DATE:	_____
Approved (CCR):	_____	DATE:	_____
Approved (CA):	_____	DATE:	_____

COMMISSIONING CERTIFICATE OF COMPLETION

_____

_____

_____

(Project Name/Address)

CONTRACTORS
The undersigned certify that the work under the responsibility of each respective trade has been completed and the associated systems are installed in accordance with the Contract Documents, applicable Code, and manufacturer's specific installation instructions. The undersigned further certify that all adjustments, start-up procedures, record documents, and commissioning have been properly completed.

1. Insert Name of Each Sub-Contractor Here, (Typical Signature Block)

(Firm)_____

_____

(Signature) (Title) (Date)

CONTRACTOR'S COMMISSIONING REPRESENTATIVE, CCR

I, _____ (Name),
of _____(Firm), certify that the Commissioning scope of work is complete in accordance with the Contract Documents and authorized change orders through _____ (date).

(Firm)_____

_____

(Signature) (Title) (Date)

OWNER
The Owner acknowledges the completion and successful commissioning of all equipment, systems, and subsystems. The Owner acknowledges that all adjustments, start-up procedures, record documents, and complete commissioning have been carried out. The Owner acknowledges receipt of the following approved documents and services:

1. Operating and Maintenance Manuals.
2. As-Built Drawings.
3. Test results and Certificates.
4. Warranties.
5. Operation and maintenance instruction, including demonstration and training digital media.

(Firm)_____

_____

(Signature) (Title) (Date)

END OF SECTION 019100

SECTION 200000 - MECHANICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Supplemental requirements in addition to Division 1 - General Requirements applicable to all Divisions 20, 21, 22, 23, 25 - Mechanical specification sections.

B. Related Sections:

1. 019100 - Commissioning
2. 200513 - Common Motor Requirements
3. 200529 - Mechanical Hangers and Supports
4. 200548 - Mechanical Vibration and Seismic Control
5. 200553 - Mechanical Identification
6. 200556 - Interior Trench Excavation and Backfill
7. 200700 - Mechanical Insulation
8. 211000 - Water Based Fire Suppression Systems
9. 213000 - Fire Pumps
10. 221100 - Domestic Water Piping and Specialties
11. 221300 - Sanitary Waste and Vent Piping and Specialties
12. 224000 - Plumbing Fixtures
13. 230593 - Testing, Adjusting and Balancing
14. 231113 - Fuel Oil Piping and Specialties
15. 231323 - Aboveground Fuel Oil Storage Tanks
16. 232113 - Hydronic Piping and Specialties
17. 232123 - Hydronic Pumps
18. 233100 - Ducts and Accessories
19. 233400 - HVAC Fans

20. 233600 - Air Terminal Units
21. 233700 - Air Outlets and Inlets
22. 235100 - Breechings, Chimneys and Stacks
23. 235223 - Cast Iron Boilers and Accessories
24. 236400 - Packaged Water Chillers
25. 237323 - Central Air Handling Units
26. 238123 - Dedicated Air-Conditioning Units
27. 238200 - Terminal Heating and Cooling Units
28. 238316 - Radiant Floor Heating Equipment
29. 253000 - Building Automation System Field Devices
30. 254000 - Variable Speed Drives
31. 255000 - Building Automation System
32. 259000 - Sequence of Operations

1.2 REFERENCES

A. Codes and Standards:

1. Perform work in accordance with the legally enacted editions of applicable international, state and local codes with locally accepted amendments to include:

   a. 2012 International Building Code (IBC).
   b. 2012 International Mechanical Code (IMC).
   c. 2015 Uniform Plumbing Code (UPC).
   d. 2012 International Fire Code (IFC).
   e. 2014 NFPA 70, National Electric Code (NEC).
   f. Standard for Accessible and Usable Buildings and Facilities (ANSI A117.1-2009).

2. Standards: Reference to the following standards infers that installation, equipment and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:

   a. American Gas Association - AGA.
   b. American National Standards Institute - ANSI.
   c. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE.
   d. American Society of Mechanical Engineers - ASME.
   e. American Society for Testing and Materials - ASTM.
   f. National Electrical Manufacturers' Association - NEMA.

g. National Fire Protection Association - NFPA.
h. Sheet Metal and Air Conditioning Contractors National Association, Inc. - SMACNA.

B. Definitions:

1. “Accessible” means arranged so that an appropriately dressed man 6'-2" tall, weighing 250 pounds, may approach the area in question with the tools and products necessary for the work intended; and may then position himself to properly perform the task to be accomplished, without disassembly or damage to the surrounding installation.

2. “Authority Having Jurisdiction” is the individual official, board, department, or agency established and authorized by the political subdivision created by law to administer and enforce the provisions of the Code as adopted or amended.

3. “As Specified” denotes a product, system, or installation that:

a. Includes salient characteristics identified in the Drawings and Specifications.
b. Meets the requirements of the “Basis of Design”.
c. Is produced by a manufacturer listed as acceptable on the Drawings or in the Specifications.

4. “Basis of Design” refers to products around which the design was prepared. Some or all of the particular characteristics of Basis of Design products may be critical to the fit or performance of the completed installation. Such characteristics are often subtle. Where substitutions are made to products that are the Basis of Design, the Contractor is alerted that nominally acceptable substitutions may produce undesirable side effects such as products that no longer fit the space due to increased product dimensions. The Contractor is responsible for resolving impacts of substitutions. Approval of a substitution request does not relieve the Contractor of complying with the design intent and applicable Codes. Reference to a specific manufacturer’s product (even as “Basis of Design”) does not necessarily establish acceptability of that product without regard to compliance with other provisions of these specifications.

5. “Contracting Agency” is the Owner as defined in the General Conditions of the Contract.

6. “Demolish” means to permanently remove a component, equipment, or system and it's appurtenances with no intent for reuse and to properly disposal of it.

7. “Furnish” means to purchase material as shown and specified, and cart the material to an approved location at the site or elsewhere, as noted or agreed, to be installed by supporting crafts.

8. “Install” means to set in place and connect, ready for use and in complete and properly operating finished condition, material that has been furnished.

9. “Product” is a generic term that includes materials, equipment, fixtures and any physical item used on the project.

10. “Provide” means furnish products, labor, subcontracts, and appurtenances required and install to a complete and properly operating, finished condition.

11. "Remove" means to remove a component, equipment, or system and its appurtenances and either store it for re-installation/reuse, or turn it over to the Contracting Agency.

12. "Rough-in and Connect" means provide an appropriate system connection such as water services with stops, continuous wastes with traps, shutoff valves, and piping connections, testing, etc., for proper operation, ready for furnished products to be installed. Equipment furnished is received, uncrated, assembled and set in place by supporting crafts unless prior arrangements are made to hire the rough-in installer for this work.

13. "Serviceable" means arranged so that the component or product in question may be properly removed and replaced without disassembly, destruction or damage to the surrounding installation. "Serviceable" components shall be "accessible".

14. "Shop Drawings" are dimensioned working construction drawings drawn to scale to show an entire area of work in sufficient detail to demonstrate service and maintenance clearances and coordination of all trades.

15. "Substitution" is a product, system or installation that is not by a listed manufacturer or does not conform to all salient characteristics identified in the Project Manual, but that the Contractor warrants meets specific requirements listed in the Project Manual.

16. "System Drawing" is a diagrammatic engineered drawing that shows the interconnection and relationship between products to demonstrate how the products interact to accomplish the function intended. Examples of system drawings include plumbing diagrams, control and instrumentation diagrams, and wiring diagrams. Some drawings, such as dimensioned and complete Fire Suppression Drawings may be both System Drawings and Shop Drawings.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Provide labor, products and services required for the complete installation, checkout, and startup of mechanical systems shown and specified. Coordinate related work, including the work of other crafts, to provide each system complete and in proper operating order.

2. Cooperate with others involved in the project; with due regard to their work, to promote rapid completion of the entire project.

3. Become thoroughly familiar with the local conditions under which the work is to be performed. Schedule work with regard to seasons, weather, climatic conditions, and other local conditions that may affect the progress and quality of the work.

4. In general, the mechanical, electrical and building automation systems are interrelated. Coordinate the interface and operation of systems so that interrelated systems operate in proper synchronization and balance.

5. Provide labor, materials, and equipment to facilitate the commissioning process of systems and equipment within this scope of work. Perform tests and verification procedures required for the commissioning process as requested by the Contracting Agency.

1.4 PREINSTALLATION MEETINGS

A. Meet with and coordinate Divisions 20, 21, 22, 23, 25 work with the interrelated work of other trades including Architectural, Civil, Structural, and Electrical to identify and resolve potential conflicts.

1.5 SUBMITTALS

A. Refer to Division 1 for general submittal requirements for the items listed below, supplemented with the additional requirements listed. In addition, prepare Divisions 20, 21, 22, 23, 25 submittals in accordance with the following.

B. General:

1. The Contracting Agency's obligation to review submittals and to return them in a timely manner is conditioned upon the prior review and approval of the submittals by the Contractor as required by the Construction Contract.

2. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Project Manual.

    a. Submittals will not be checked for quantity, dimension, fit, or for proper technical design of manufactured equipment.
    b. Provision of a complete and satisfactory working installation is the responsibility of the Contractor.

3. Furnish suppliers with the applicable portions of the Project Manual and review and verify that the suppliers' submittals clearly represent products which comply with the Project Manual.

4. Master Submittal Log]

    a. Create and maintain a master submittal log for items submitted in Divisions 20, 21, 22, 23, 25, including test results, certifications, record drawings, etc.
    b. Submit master submittal log, independent of other submittals, as the first submittal for review and approval by the Contracting Agency.
    c. Update submittal log with each submittal action.
    d. Share an electronic copy with Contracting Agency and Engineer at two week intervals, or as requested by the Contracting Agency.

C. Coordination:

1. Prior to a submittal's submission for approval, hold a meeting of all construction trades to review shop drawings and submittals. Each trade shall cross-check shop drawings and submittals for conflicts, clearances, physical space allocation and routing, discrepancies, dimensional errors, omissions, contradictions, departures from the Contract requirements, correct electrical/mechanical services and connections, and provisions for commissioning.

2. Review, revise, correct, and appropriately annotate submittals prior to submission for approval.

3. Keep a current copy of approved submittals and the submittal log at the job site.

D. Electronic Submittals:

1. Provide electronic submittals in PDF format in addition to hard copy submittal. Maximum file size to be coordinated with Contracting Agency.

2. Follow the organization and formatting required for paper submittals.

3. Provide electronic bookmarks within the PDF document in place of tabs and sub-tabs.

4. If individual PDF files are provided for a product or shop drawing sheet(s), organize files into folders and name files and folders to correspond with applicable specification sections or drawing titles.

5. Create PDF documents without security, to be searchable, and to allow copy and paste. For scanned documents, run the optical character recognition (OCR) function to ensure the document is searchable and can be copied and pasted.

6. Reduce PDF file size by removing data and file creation elements not needed for final file presentation.

E. Product Data:

1. General:

a. This section describes in detail the preparation of mechanical product submittals. Submittals not provided as described shall be rejected without review. This procedure is designed to accelerate and improve the accuracy of the technical review process, as well as, simplify the preparation of the Installation, Operation, and Maintenance Manuals (IO&Ms).
b. Product data for each specification section shall be submitted in one complete package, except as noted in this section.

2. Submittal Organization:

a. Organize product submittal information in the same order as the products are specified. Provide a separate tabbed divider for each Divisions 20, 21, 22, 23, 25 specification section. Provide the typed section number on each tab.
b. Within each section, organize product information in the same order as products are specified in Part 2 of each applicable specification section. Provide sub-tabs within each section for each separate product article. Provide the typed product article number on each tab.
c. Provide product submittal information for each product specified in 8-1/2” x 11” format. Fold-out 11” x 17” format is also acceptable.
d. If a particular specified product is being omitted from the product submittal or will not be used for the project, provide a single sheet within the article tab identifying the product and annotated with a brief reason why the product is not being submitted, for example: “NOT USED,” NO SUBMITTAL REQUIRED,” “TO BE SUBMITTED BY (PROVIDE DATE),” etc. This will inform the reviewer that the product was not overlooked.

e. Partial submittals from individual subcontractors may be provided which cover a particular sub-contractor's scope of work. In this case, arrange partial submittals by system classification such as: PLUMBING, HEATING, FIRE SUPPRESSION, VENTILATION, BUILDING AUTOMATION SYSTEM, etc. Within each system classification, arrange product submittals by specification section, as described, such that each specification section can easily be reorganized into a master set of Divisions 20, 21, 22, 23, 25 product submittals organized by specification section. This will greatly simplify the preparation of IO&M manuals as described below.
f. Bind product submittal information in identical 3 inch wide, hard-backed, loose-leaf, 3 ring binders with clear front and spine insert pockets. Divide information into multiple volumes so that the pages in each binder rest naturally on one side of rings.
g. Provide a master table of contents at the front of each volume which lists the Divisions 20, 21, 22, 23, 25 specification sections and indicates which sections are located within each volume.
h. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
i. Provide identical cover and spine inserts for each product submittal volume, to include the following typed information:
   1). The Contracting Agency Name.
   2). Project Name.
   3). Contractor Name.
   4). Subcontractor Name preparing the submittal.
   5). Date that the submittal or resubmittal was initiated.
   6). "Mechanical Product Submittals" or "Plumbing Product Submittals" etc. as appropriate.
   7). "Volume 1 of X, Volume 2 of X," etc.

3. Product Information:

   a. Indicate manufacturer's name and address, and local supplier's name, address, phone number.
   b. Indicate each product as "Basis of Design", "Specified Equal" or "Proposed Substitution."
   c. Identify catalog designation and/or model number.
   d. Provide manufacturer's product literature. Neatly annotate to indicate specified salient features, appurtenances and performance criteria for each product specified to demonstrate compliance with the Project Manual to include scheduled information, drawing information and specified information.
   e. Indicate product deviations from the Project Manual and mark out non-applicable items on generic "cut-sheets."
   f. Include manufacturer provided dimensioned equipment drawings with rough-in mechanical and electrical connections.
   g. Include operation characteristics, performance curves and rated capacities.
   h. Include motor characteristics and wiring diagrams.
   i. Include weight of equipment. Including accessories.
   j. Provide basic manufacturer's installation instructions.

4. Product Substitutions:

a. Clearly indicate both in the section table of contents and on the individual product submittal information each proposed substitution, deviation or change from the product as described in the Project Manual.
b. Submittal approval does not include substitutions, deviations or changes from the requirements of the Project Manual unless they are specifically itemized and approved. The term "No Exceptions Taken" will not apply to substitutions, deviations or changes not clearly identified.
c. Provision of a satisfactory working installation of equal quality to the system as described in the Project Manual shall be the responsibility of the Contractor.
d. Correct unapproved deviations from the Project Manual discovered in the field as directed by and at no additional cost to the Contracting Agency.
e. Cost of any design modifications as a result of proposed product substitutions shall be borne by the Contractor.

F. System Drawings:

1. Submit System Drawings for dynamic elements/systems of the project which are performance specified to include but not limited to: Fire Suppression Systems, Building Automation Systems and stand-alone packaged equipment.

2. Prepare system drawings on full sized sheets of the same size as the original construction drawings.

3. Include with each system a sequence of operation narrative which describes each mode of system operation in sufficient detail to demonstrate compliance with the Project Manual to the satisfaction of the Contracting Agency.

G. Shop Drawings:

1. General:

a. The Project Manual documents are not intended for nor are they suitable for use as shop drawings. Project Manual documents shall not be utilized for the actual fabrication or installation of products or equipment.
b. The Drawings are partly diagrammatic and do not show all offsets in piping or ducts, and may not show in minute detail all features of the installation; however, provide systems complete and in proper operating order.
c. Locations of products are approximate unless dimensioned.
d. Divisions 20, 21, 22, 23, 25 products and systems shall not be installed without shop drawings approved by the Contracting Agency.
e. Rework, changes or additional engineering support required as a result of the installation of products and systems prior to the approval of applicable shop drawings by the Contracting Agency shall be provided at the Contractor's expense.
f. Drawing symbols used for basic materials, equipment and methods are commonly used by the industry. Special items are identified by a supplementary list of graphical illustrations, or identified on the drawings or specifications.

2. Preparation:

a. Review each Divisions 20, 21, 22, 23, 25 specification section and identify the shop drawing requirements.

b. Combine the shop drawing requirements first by system (i.e. ventilation system, heating system, plumbing system, etc.) and then by area (i.e. fan room, boiler room, etc.).
c. Prepare shop drawings on full sized sheets of the same size as the original construction drawings.
d. Arrange shop drawings to scale, showing dimensions where accuracy of location is necessary for coordination or communication purposes.
e. Incorporate the actual dimensions and configurations of the products and systems approved through the product submittal process into the shop drawings.
f. Provide dimensioned maintenance clearance areas around each product as recommended by the manufacturer.
g. Coordinate Divisions 20, 21, 22, 23, 25 work with the interrelated work of other trades including Architectural, Civil, Structural, and Electrical.
h. Identify and provide recommendations to resolve major conflicts which may impact the design of the systems as shown. Such conflicts will be resolved during the shop drawing review process.
i. Identify locations where field coordination between various trades is necessary to avoid conflicts.
j. Indicate elevation of piping, ductwork and equipment above or below finished floor at various locations and in sufficient detail to demonstrate clearance from structural elements and the work of other trades.
k. Coordinate placement of openings and holes through structure, walls, floors, ceilings, and roof with Structural and Architectural.

3. Submittal:

a. Submit dimensioned shop drawings as specified to demonstrate proper planning and sequencing of the applicable trades for the installation and arrangement of Divisions 20, 21, 22, 23, 25 with respect to other interrelated work.
b. Partial shop drawings submittals (i.e. heating system only) will be rejected without review, as the interrelationship with other related work and overall system fit cannot be evaluated.
   1). Underslab shop drawings may be submitted separately for review to accommodate the construction schedule.

c. It is assumed that shop drawings submitted for review have been thoroughly prepared and coordinated and that the products and systems can and shall be installed as shown. Conflicts which are not clearly identified and annotated on the submitted shop drawings are assumed not to exist.
d. Installation conflicts arising from the failure to properly coordinate the work of related trades shall be provided at the Contractor's expense.

H. Certificates:

1. Review the submittal requirements for Certificates for each Divisions 20, 21, 22, 23, 25 specification section.

2. Submit copies of certificates as specified. This information may be included within the Installation, Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.

I. Test and Evaluation Reports:

1. Review the submittal requirements for Test and Evaluation Reports for each Divisions 20, 21, 22, 23, 25 specification section.

2. Submit copies of reports as specified. Also include these reports within the Installation, Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.

J. Installation, Operations and Maintenance (IO&M) Manuals:

1. Review the submittal requirements for IO&M manuals for each Divisions 20, 21, 22, 23, 25 specification section.

2. Begin the preparation of the mechanical IO&M manuals with a complete and fully approved set of mechanical product data submittals organized, annotated and with the product information as indicated within the "Product Data" submittals article above and in each Divisions 20, 21, 22, 23, 25 section.

3. Next, augment each individual product submittal with the written installation, operations and maintenance information for each approved product. This type of information is not applicable (or available) for bulk commodity or simplistic products such as copper pipe, basic pipe hangers or equipment tags, etc.

4. Annotate the installation, operations and maintenance information to indicate applicable information for the specific equipment model(s) installed.

5. Maintenance information shall include:

   a. Preventive maintenance requirements for each product, including the recommended frequency of performing each preventive maintenance task.
   b. Instructions for troubleshooting, minor repair and adjustments required for preventive maintenance routines, limited to repairs and adjustments that may be performed without special tools or test equipment and that require no extensive special training or skills.
   c. Information of a maintenance nature covering warranty items, etc., that have not been discussed in the manufacturers' literature.
   d. Information on the spare and replacement parts for each product and system. Properly identify each part by part number and manufacturer.
   e. Recommended spare parts list.

6. Organize the IO&M manual information by specification section (not by sub-contractor) with a tabbed divider separating each section. Provide the typed section number on each tab.

7. Within each section, organize the product information in the same order as the products are specified in Part 2 of each applicable section. Provide sub-tabs within each section for each product. Provide the typed product article number on each tab.

8. Bind the information in identical 3 inch wide; hard-backed, loose-leaf, 3 ring binders with clear front and spine insert pockets. Divide information into multiple volumes so that the pages in each binder rest naturally on one side of rings.

9. Provide a master table of contents at the front of each volume which lists the Divisions 20, 21, 22, 23, 25 specification sections and indicates which sections are located within each volume.

10. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.

11. Provide identical cover and spine inserts for each IO&M manual volume, to include the following typed information:

    a. The Contracting Agency Name.
    b. Project Name.
    c. "Mechanical Installation, Operations and Maintenance Manual".
    d. "Volume 1 of X, Volume 2 of X," etc.

12. Submit copies of Operation and Maintenance Manuals in electronic format (Adobe PDF).

1.6 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Review the manufacturer's warranty requirements for each Divisions 20, 21, 22, 23, 25 specification section.

2. Submit required warranty documentation to the applicable Manufacturer's Representative to validate standard manufacturer's warranty for each required product. Obtain written confirmation of receipt from each applicable Manufacturer's Representative.

3. Provide Contracting Agency one copy of submitted warranty documentation and written confirmation of receipt for each applicable Manufacturer's Representative. This information may be included within the Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.

4. Provide statement of Contractor's warranty of workmanship, labor, and materials, as described under Article 1.12 Warranty below.

B. Record Documentation:

1. General: As the Work progresses, neatly annotate a designated and otherwise unused set of Divisions 20, 21, 22, 23, 25 Contract Drawings to show the actual locations and routing of Divisions 20, 21, 22, 23, 25 Work and the terminal connection points to related Work. As a minimum, include the following:

    a. Annotate record drawings to incorporate each applicable addendum.
    b. Annotate record drawings as directed by each applicable Request for Information (RFI) and accepted Change Order Proposal.
    c. Modify record drawings to show actual equipment sizes and locations and pipe and duct routing. Revise pipe and duct sizes as appropriate.
    d. Provide dimensioned locations for permanently concealed piping and ductwork (i.e. piping cast in concrete or buried underground/underslab).

e. Show the actual locations of system isolation valves, especially valves which are concealed above ceilings and behind access panels.

2. Preparation:

a. Neatly annotate record drawings to provide clear interpretation to support electronic drafting by a third party.
b. Tape electronic sketches from addendums and/or RFIs directly to the record drawings as overlays.
c. Annotate the record drawings in colored pencil using the same symbols and abbreviations as indicated in the Divisions 20, 21, 22, 23, 25 legends and schedules of the Contract Drawings.
   1). Red to add information.
   2). Green to delete information.
   3). Blue to provide additional clarifying information which is not to be drafted.

d. After submittal to the Contracting Agency, provide additional clarification, information or rework as necessary to support the accurate interpretation and electronic drafting of the record drawings.

3. Submittals:

a. Provide dimensioned underslab record drawings to the Contracting Agency prior to placing the slab. For slabs placed in multiple sections, provide record drawings for the applicable slab sections to the Contracting Agency prior to each pour.
b. Provide complete record drawings for concealed areas (i.e. above lay-in and hard ceilings and inside walls) to the Contracting Agency prior to concealment.
c. Provide the remaining portion of the record drawings for exposed areas to the Contracting Agency prior to the final completion of the project.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. Furnish spare parts for systems and equipment as listed in applicable sections of Divisions 20, 21, 22, 23, 25.

2. Clearly label each part with name, manufacturer’s part number, system and/or equipment where used and location.

3. Deliver parts to location and person designated by the Contracting Agency, in durable storage boxes.

4. Group cartons containing smaller items by system or application and deliver in an appropriate number of storage boxes.

B. Tools: Provide three sets of special tools and testing and monitoring equipment as listed in applicable sections of Divisions 20, 21, 22, 23, 25.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Companies specializing in manufacturing the Products specified in the Divisions 20, 21, 22, 23, 25 sections with documented experience.

2. Fabricators: Companies specializing in fabricating the Products specified in the Divisions 20, 21, 22, 23, 25 sections with documented experience.

3. Installers: Perform the Work using qualified workmen that are experienced and usually employed in the trade.

4. Testing Agencies: Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and as indicated.

B. Product Testing and Certification:

1. Nationally Recognized Testing Laboratory (NRTL) Labeling: Electrical equipment and conductors shall be "Approved," "Certified," "Identified," or "Listed" and "Labeled" to establish that the electrical equipment is safe, free of electrical shock and fire hazard, and suitable for the purpose for which it is intended to be used. The manufacturer shall have the specific authorization of one of the Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratories (NRTLs) in accordance with the applicable national standards to label the equipment as suitable.

2. Where the words Listed, UL Listed, UL Labeled, Underwriters Laboratories, Inc., UL, or variations of this terminology, appear under this Division of the Specifications or the associated drawings, it is understood that a comparable testing agency as defined by NRTL above is acceptable.

3. Such testing and certification is generally applicable to products within the following categories:

a. Life safety and fire suppression.
b. Fuel burning equipment, except certain classes of power or industrial equipment for which other recognized certification applies as well.
c. Factory fabricated and wired electrical control panels and packaged equipment with factory installed electrical controls or panels.
d. Components for life safety systems, fuel systems and medical gas systems.

4. The listing under Paragraph '3' above is provided for illustration of requirements and is not exclusive. Provide products that have been tested and listed for the intended application when such products are available unless the Contracting Agency has provided written exemption on an itemized basis.

5. Provide electrical products listed and labeled by UL, FM, ETL or other approved NRTL. If listing and labeling is not available, stamp the submittal for these products by an Alaska Registered Professional Engineer approved by the Authority Having Jurisdiction, at no additional cost.

6. Where interpretation is required, the Contracting Agency will provide direction and will be the sole judge in cases of compliance with this subsection.

1.9 DELIVERY, STORAGE AND HANDLING

A. Delivery and Acceptance Requirements:

1. Verify products are new and delivered in original factory packaging/crating and are free from damage and corrosion.

2. Replace products delivered to job site that does not comply with above requirements at no expense to Owner.

3. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Handling Requirements:

1. Store products in covered storage area protected from the elements, outside the general construction area until installed.

2. Store products in original factory packaging until actual installation.

3. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

4. Replace damaged items with same item in new condition.

1.10 WARRANTY

A. See Division 1 for general warranty requirements.

B. Warranty workmanship, labor, and materials for a period of one year from the date of final acceptance, without limitation, except where longer warranty periods are specified in a specific Section under this Division, or in the General Conditions of the Contract. Promptly coordinate and perform Warranty work at the Contractor’s sole expense.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Cover and protect open ends and individual components of the ventilation and piping systems during construction when dust, dirt, debris, overspray, or other potential construction contaminates could enter the air distribution system or elements (ducts, fans, VAV boxes, silencers, etc.).

2. Provide temporary construction filters over return airshaft openings and at air handling unit return air dampers.

3.2 INSTALLATION

A. Special Techniques:

1. Provide temporary heating to maintain the building at 65 degrees F.

2. Provide temporary ventilation with filtration during construction.

B. Interface with Other Work:

1. Electrical Work:

a. Coordinate with Division 26.
b. See also specification section 200513 - Common Motor Requirements.
c. Suggested Coordination Schedule: The Contractor is responsible to provide heating, ventilating, and plumbing equipment motors and controls, including fire suppression controls. Unless otherwise indicated on the Drawings, it is recommended that motors and controls be furnished, set in place, and wired in accordance with the following schedule. "CC" applies to either a Control subcontractor working as a sub to the General Contractor or to the Divisions 20, 21, 22, 23, 25 Mechanical subcontractor. Coordinate work between subcontractors.

MC - Divisions 20, 21, 22, 23, 25-Mechanical CC - Divisions 20, 21, 22, 23, 25-Controls EC - Divisions 26, 27 and 28-Electrical	Furnished By	Set in Place By	Power By	Control By
Equipment Motors	MC	MC	EC	CC
*Magnetic motor starters:				
Automatic controlled, w/ or w/o HOA switches	EC	EC	EC	CC
Automatic controlled, w/ or w/o HOA switches, and that are furnished as part of factory wired equipment	MC	MC	EC	MC
*Manual Motor Starters:				

MC - Divisions 20, 21, 22, 23, 25-Mechanical CC - Divisions 20, 21, 22, 23, 25-Controls EC - Divisions 26, 27 and 28-Electrical	Furnished By	Set in Place By	Power By	Control By
Manually controlled	EC	EC	EC	EC
Manually controlled, and that are furnished as part of factory wired equipment	MC	MC	EC	MC
Combination disconnect and motor starter	EC	EC	EC	CC
Motor Control Centers	EC	EC	EC	CC
Variable Speed Drives	MC	EC	EC	CC
Push-button stations, pilot lights, contactors, multi-speed switches	EC	EC	EC	EC
Disconnect switches, thermal overload switches, manual operating switches	EC	EC	EC	--
Multi-speed switches furnished as part of factory wired equipment	MC	MC	EC	MC
Temperature control relays, transformers, electric thermostats, time clocks, etc., that are not part of factory furnished equipment	CC	CC	CC	CC
Remote bulb thermostats, motor valves, controls, which are an integral part of factory furnished mechanical equipment.	MC	MC	EC	MC
Fire sprinkler suppression controls	MC	MC	EC	MC
Duct smoke detectors, including relays for fan shutdown	MC	MC	EC	EC
Fire/Smoke Dampers	MC	MC	EC	EC
Control Systems	CC	CC	CC	CC
Damper & Valve Actuators (120 v)	CC	CC	EC	CC
Damper & Valve Actuators (24 v)	CC	CC	CC	CC
Master Building Power quality monitors (loss/reversal)	EC	EC	EC	CC
Boiler and water heater controls, boiler burner control panels, internally wired	MC	MC	EC	MC
Electric Generator(s)				
Genset(s)	EC	EC	EC	EC
Fuel Lines	MC	MC	--	--
Day Tank (if separately furnished)	MC	MC	EC	MC
Silencer	EC	MC		

* Provide starters in accordance with the Electrical Division of these Specifications. Note that a thermal overload relay in each phase is required for each starter (packaged equipment included).

2. Coordination with Room Numbering:

    a. Certain systems provided under this Division rely on identification systems that are based on room names or numbers.
    b. The numbering scheme indicated in this Project Manual is based on room numbers assigned during the design process.
    c. The Contracting Agency reserves the right to change the numbers prior to Substantial Completion, and the final names and numbers will not necessarily match those found in the Project Manual.
    d. Obtain from The Contracting Agency the final room numbers prior to commencing the numbering of Divisions 20, 21, 22, 23, 25 systems.
    e. Tag and label system equipment and devices in accordance with the final numbering scheme at no additional cost.

3.3 REPAIR/RESTORATION

A. Touch-up, repair or replace product components broken during installation or startup with new replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

C. Clean and repair existing identification tags/labels, hangers, supports, insulation, materials, instrumentation, and equipment that remain or are to be reused or are affected by this work. Materials and equipment which require major repair may be replaced at the Contractor's option.

D. Plug, patch and repair surfaces, adjacent construction, and finishes damaged during demolition and new work. Restore to original condition or better including fire, smoke or temperature ratings or listings. Retexture surfaces to match surrounding surfaces. Repaint affected surfaces, with extent of paint to include adjacent surfaces to next wall or other clean break to avoid mismatched finish. Replace cracked or damaged ceiling tiles. Repair fire proofing, assembly fire ratings, and construction resistant to the passage of smoke.

3.4 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. The Contracting Agency may inspect and approve sample installation of systems and equipment prior to general installation of units.

2. Schedule, obtain, and pay for fees and/or services required by the local Authorities Having Jurisdiction and by these specifications, to test the mechanical systems.

3. Notify the Contracting Agency a minimum of 24 hours in advance of tests. Certify in writing that specified tests have been made in accordance with the specifications.

4. Immediately correct deficiencies that are discovered during the tests and repeat tests until system is approved. Do not cover or conceal piping, equipment or other portions of the mechanical installations until satisfactory tests are made and approved.

5. Under the direction of the Contractor and in the presence of the Contracting Agency, place the entire mechanical installation and/or any portion thereof in operation to demonstrate satisfactory operation.

6. Arrange for the Contracting Agency to witness tests. The Contracting Agency may waive witnessing any specific test at its discretion.

B. Non-Conforming Work:

1. Expediently remove and provide new for work not conforming to the Project Manual upon discovery; including warranty and discovery periods.

2. Warranty period shall start over for replaced equipment and installation from the date of accepted by the Contracting Agency.

C. Manufacturer Services:

1. Authorized manufacturer's representative shall be on-site for testing, start-up, functional check-out, and commissioning of equipment and systems.

2. Procurement, installation, start-up, and warranty services to be provided by manufacturer's authorized representative and service company.

3. Equipment, devices, hardware, and software to be approved for application, and of current production. Original manufacturer's parts, hardware, software, and support to be available for ten years after installation.

3.5 CLEANING

A. Upon completion of installation and prior to initial operation, remove debris, and clean and wipe down equipment, piping, ductwork and floor to eliminate dust and dirt.

3.6 CLOSEOUT ACTIVITIES

A. Demonstration: Provide demonstration, conducted by authorized factory start-up personnel, to the Contracting Agencies authorized personnel as listed in each individual specification section.

B. Training: In addition to training specified in each individual specification section, provide 8 additional hours of operational instruction conducted by qualified personnel, covering any of the mechanical systems and installation requested by the Contracting Agency to its authorized maintenance personnel.

END OF SECTION 200000

SECTION 200513 - COMMON MOTOR REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: This section describes general requirements, products and methods of execution relating to electric motors in general and shall apply to motors furnished as integral parts of equipment specified in this and other Divisions.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 232123 - Hydronic Pumps
4. 233400 - HVAC Fans
5. 235223 - Cast Iron Boilers and Accessories
6. 236400 - Packaged Water Chillers
7. 237323 - Central Air Handling Units
8. 238123 - Dedicated Air-Conditioning Units
9. 238200 - Terminal Heating and Cooling Units
10. 254000 - Variable Speed Drives

1.2 REFERENCES

A. Codes and Standards: National Electrical Manufacturers Association, NEMA, Standards Publication Motors and Generators, MG-1.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements: Provide product performance characteristics as specified or scheduled on drawings.

1.4 PREINSTALLATION MEETINGS

A. Coordinate installation of electrical motors with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

1.5 SUBMITTALS

A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Provide a tabular listing of motors including the following information: Tag (from drawings), location, function, actual nameplate FLA, fuse size used, overload relay used, and overload setting.

2. Make copy of list available during Substantial Completion observation by the Contracting Agency. Include list in Operations and Maintenance Manuals.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Company specializing in manufacturing the Products specified in this section with minimum 3 years' experience.

B. Certifications: Motors shall conform to governing NEMA Standards and ASA Form C-50 for rotating machinery.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery and Acceptance Requirements:

1. Verify motors are new and delivered in original product/factory packaging/crating and are free from damage and corrosion.

2. Replace products delivered to job site that do not comply with above requirements at no expense to Owner.

B. Storage and Handling Requirements:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.8 WARRANTY

A. Manufacturer Warranty: See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 MOTORS IN ELECTRICAL CLASSIFIED LOCATIONS

A. Motors used in environments indicated to be NEC Class I, Division I shall be built and labeled as explosion-proof for the Group and autoignition temperature, NEC T-code.

B. Motors used in environments indicated to be NEC Class I, Division II:

1. Listed for Class I Division I environments.

2. Listed for Class I Division II environments.

3. Does not have arc-producing brushes or switching mechanisms which could act as ignition sources.

4. Motors that include a space heater, its surface temperature may not exceed 80% of the autoignition temperature of the hazard.

2.2 SUPPLY VOLTAGE

A. Supply voltage shall be determined from the electrical plans where nominal utility voltage will be indicated.

B. Motor voltage shall be stamped on the nameplate and relate to the nominal voltage as follows:

THREE PHASE MOTORS	
Nominal Volts	Motor Ratings
208 volts	200V, 208V, or 208/220V
240 volts	220V or 208/220V
480 volts	460V
SINGLE PHASE MOTORS	
Nominal Volts	Motor Ratings
120 volts	115V or 115/230V
240 volts	230V or 115/230V
208 volts	200V or 208V

Note: Provide nameplate indicating that voltage for a motor operating at 208 VAC is suitable.

C. Provide two sets of windings for two speed motors. Furnish two-speed starter to suit motor for two-speed motors. Starter to be installed under Division 26.

D. Voltage variation: Motors shall be designed to operate within the parameters of these requirements at rated load and with a voltage variation from the name plate voltage of plus or minus ten percent.

E. Motors shall operate successfully at rated load and at rated voltage with a maximum frequency variation of five percent above or below rated frequency.

F. Motors shall operate successfully at rated load with a combined maximum variation in the voltage and frequency of five percent above or below rated voltage and rated frequency.

G. Motors that operate with Variable Speed Drive (VSD) controllers shall be suitable for the application.

1. Motors operated using PWM type VSDS: Conform to NEMA MG 1 Part 31 requirements.

2. Motors operated using six-step type VSDS: Conform to NEMA MG 1 Part 30 or Part 31 requirements.

2.3 LOCKED ROTOR CURRENT

A. No motor above 15 HP shall have a locked rotor current in excess of NEMA code letter “G”. Smaller motors may have a higher locked rotor rating, but in no case exceeding the recommended NEMA rating as related to motor size.

2.4 MOTOR INSULATION

A. Unless otherwise specified, motor insulation shall be NEMA Class “B” (or better). Based on 40 degrees C maximum ambient, and 90 degrees C maximum rise, total maximum operating temperature shall not exceed 130 degrees C.

2.5 MOTOR LOADING

A. No motors shall be subjected to loads exceeding the motor nameplate rating, under any normal operating condition.

2.6 MOTOR RATING

A. Motors are sized in conformity with the manufacturer’s published information and shall not be interpreted as the final requirement. Check each motor for adequacy in relation to the specific application.

B. Motors indicated as being connected to variable speed drives (VSD) shall be rated for VSD service.

2.7 HIGH EFFICIENCY AC MOTORS

A. Furnished high efficiency electric motors for equipment that:

1. Require a three horsepower or larger drive motor.

2. Have duty cycles classified as continuous.

B. Efficiency of the motors shall be determined by NEMA Standard MG 1 - 12.536 and shall have efficiencies equal to or better than:

Motor Size	Nominal Efficiency
Through 3 HP	89 percent
Over 3 HP through 10 HP	91 percent
Over 10 HP through 30 HP	93 percent
Over 30 HP through 60 HP	94 percent
Over 60 HP through 100 HP	95 percent
Over 100 HP	95 percent

2.8 MOTOR HOUSING FEATURES

A. Open drip-proof, totally enclosed fan cooled (TEFC), or explosion-proof, as appropriate for the use intended and the environment where installed, or as noted. Provide totally enclosed fan cooled motors for equipment below grade, located outdoors, or operating in damp or dust-laden locations. Provide a continuous moisture drain that is screened against insect entry for totally enclosed motors.

B. Oversized external conduit boxes at least one size larger than NEMA standard.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions: Cover motors to protect them from construction dirt and debris.

3.2 INSTALLATION

A. Special Techniques:

1. Installation of motors shall be as required by the driven equipment. Make sure motor design and characteristics are suitable for the application.

2. Electrical connections for motors shall conform to NEC Articles 430 and 440 as applicable, and to any state and local code having jurisdiction.

3. Unless furnished as part of a complete package including disconnects and control, and/or motor fuse protection, protect motors by Bussmann Fusetron Dual-Element Time Delay fuses, or approved equal.

4. Megger motor windings prior to starting. Include log of megger readings in the Operations and Maintenance manuals.

5. Verify correct rotation of motors.

6. Comply with Article 460 of the National Electrical Code for installation of power factor correction capacitors.

7. Motor sizes shown on the Drawings are estimates based upon the mechanical design. Where motors actually furnished are of a different size than those shown, motor circuit components (starters, disconnects, overcurrent devices, and conductors) shall be revised to suit the motors actually furnished, without increase in the Contract amount. Similarly, motor overcurrent device sizes shown on the Drawings or specified are based upon estimated motor code letters, overcurrent device manufacturers' recommendations, and full-load currents from the NEC Tables. Where the motors actually furnished require different sizing, the sizes of the overcurrent devices shall be adjusted to conform to the NEC, without increase in the Contract amount.

3.3 REPAIR/RESTORATION

A. Repair any components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

END OF SECTION 200513

SECTION 200529 - MECHANICAL HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General hanger and support requirements for building service piping and mechanical equipment not required to be vibration and/or seismically controlled.

2. Penetrations, sleeves and seals.

B. Products Installed But Not Supplied Under this Section:

1. Vibration Isolation and Seismic Control anchoring and support systems furnished by Section 200548 - Mechanical Vibration and Seismic Control.

C. Related Sections:

1. 019100 - Commissioning

2. 033000 - Cast-in-Place Concrete

3. 075000 - Single-Ply EDPM Membrane Roofing

4. 099100 - Painting

5. 200000 - Mechanical General Requirements

6. 200513 - Common Motor Requirements

7. 200548 - Mechanical Vibration and Seismic Control

8. 200553 - Mechanical Identification

9. 200700 - Mechanical Insulation

10. 221100 - Domestic Water Piping and Specialties

11. 221300 - Sanitary Waste and Vent Piping and Specialties

12. 224000 - Plumbing Fixtures

13. 231113 - Fuel Oil Piping and Specialties

14. 232113 - Hydronic Piping and Specialties

15. 232123 - Hydronic Pumps

16. 233100 - Ducts and Accessories
17. 233400 - HVAC Fans
18. 233600 - Air Terminal Units
19. 233700 - Air Outlets and Inlets
20. 235100 - Breechings, Chimneys and Stacks
21. 235223 - Cast Iron Boilers and Accessories
22. 236400 - Packaged Water Chillers
23. 237323 - Central Air Handling Units
24. 238123 - Dedicated Air-Conditioning Units
25. 238200 - Terminal Heating and Cooling Units
26. 238316 - Radiant Floor Heating Equipment
27. 254000 - Variable Speed Drives

1.2 REFERENCES

A. Codes and Standards:

1. International Building Code (IBC).
2. International Mechanical Code (IMC).
3. Uniform Plumbing Code (UPC).
4. MSS SP58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
5. SMACNA HVAC Duct Construction Standards - Metal and Flexible (current edition).

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.
2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.
3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

1.3 DESCRIPTION

A. Design Requirements:

1. Equipment and piping system support:

a. Select and apply pipe hangers and supports per MSS SP58 using stock or production parts whenever possible.
b. Design support spacing such that free span of piping does not exceed Code or MSS SP58 criteria (whichever is most restrictive).
c. Calculate required supporting force at each hanger location to confirm hanger type and hanger rod diameter selection.
d. Provide hangers such that equipment connection points do not carry connected piping load.

2. Vibration and seismic restraint systems: Coordinate the requirements of this section with Section 200548 - Mechanical Vibration and Seismic Control.

B. Performance Requirements:

1. Provide hangers and supports which allow for the free expansion and contraction of system piping without transferring tensile and compressive stresses to adjacent supports or connected equipment. Provide additional expansion loops, pipe anchor and pipe guide assemblies as required.

2. Coordinate hanger and support anchor locations and embedment depth requirements with structural.

3. Support fire suppression system piping and equipment accordance with the provisions of Section 211000 - Water Based Fire Suppression Systems.

4. Support plumbing piping in accordance with this section and Uniform Plumbing Code requirements; whichever is more restrictive. In case of conflicts, follow UPC guidance.

5. Support ductwork in accordance with Section 233100 - Ducts and Accessories.

6. Special Performance Requirements for Open Ceiling Spaces:

a. Coordinate the support of piping, ductwork, lighting and electrical cabling in open ceiling spaces (utilizing the shop drawing review process) to provide a uniform and symmetrical appearance.
b. In general, utilize trapeze hanger style support systems with hangers equally spaced based on the limiting component being supported. Provide hanger rods vertical and straight. Trim hanger rod ends to provide a “finished” appearance.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate installation of equipment and associated piping or ductwork with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

1.5 SUBMITTALS

A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Provide manufacturers catalog data, including load capacity, embedment depth.

2. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

C. Shop Drawings:

1. Provide shop drawings for housekeeping pads (with dimensioned penetrations) and field fabricated support systems.

2. Provide shop drawings to show system layout with location and detail of hangers, anchors, dimensioned expansion loops and guides. Coordinated with Section 200548 - Mechanical Vibration and Seismic Control shop drawing submittal.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance (IO&M) Manuals:

1. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.

2. Include the following:

a. Copies of approved submittal information.
b. Manufacturer's installation, operating and maintenance/repair instructions, parts listings, and spare parts list for each product. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.

C. Record Documentation:

1. Indicate installed locations of hangers, supports and expansion control assemblies on record drawings on associated piping record drawings.

2. Provide Operating and Maintenance Data (installation and adjustment instructions) for non-commodity products.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years documented experience.

2. Installers: Minimum 3 years' experience.

3. Testing Agencies: Provide piping and support systems designed and manufactured per MSS SP58.

4. Licensed Professionals: Provide piping and support systems designed per MSS SP58.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:

1. Verify products are delivered in original factory packaging and are free from damage and corrosion.

2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Owner.

B. Storage and Protection:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

2. Handle items to avoid damage.

3. Replace damaged items with same item in new condition.

1.9 WARRANTY

A. Manufacturer Warranty:

1. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

2. Provide 1 year manufacturer's warranty.

3. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.

4. Provide to the Contracting Agency 1 copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. General:

1. Piping and support systems shall be malleable iron, steel or copper.

2. Ferrous hangers and supports installed outdoors or in unheated spaces shall be hot dipped galvanized.

3. Select and apply pipe hangers and supports per MSS SP58.

   a. Use stock or production parts whenever possible.
   b. Calculate weight balance to determine the required supporting force at each hanger location and to eliminate pipe weight load at each equipment connection.

4. Fabricate and install pipe hangers and supports per MSS SP58 recommended practices.

5. Hangers shall be designed to securely lock using a mechanical fastener. Hangers and supports using gravity type locking are not acceptable. For example, adjustable swivel ring Type 6 is not allowed.

6. Pre-engineered support systems such as Unistrut, Super-Strut, B-Line and K-Line may be used in accordance with manufacturers load limits.

7. Manufacturers: Grinnell, M-CO Michigan Hanger Company, Kin Line.

B. Plumbing Piping:

1. Conform to the Uniform Plumbing Code requirements.

2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Adjustable swivel ring; split ring.

3. Hangers for DWV and Cold Pipe Sizes two inch and over: Carbon steel, adjustable, clevis.

4. Hangers for Hot Pipe sizes two to four inch: Carbon steel, adjustable, clevis.

5. Hangers for Hot Pipe Sizes six inches and over: Adjustable steel yoke, cast iron roll, double hanger.

6. Multiple or Trapeze Hangers under six inches: Steel channels with welded spacers and hanger rods.

7. Multiple or Trapeze Hangers for Hot Pipe Sizes six inches and over: Steel channels with welded spacers and hanger rods, cast iron roll.

8. Wall Supports: Welded steel bracket and wrought steel clamp.

9. Wall Support for Hot Pipe Sizes six inches and over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

10. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.

11. Floor Support for Hot Pipe Sizes up to four inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.

12. Floor Support for Hot Pipe Sizes six inches and over: Adjustable cast iron roll and stand, steel screws, and steel support.

13. Vertical Support: Steel riser clamp.

14. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Hydronic Piping:

1. Conform to ASME B31.9 and the International Mechanical Code.

2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Adjustable swivel ring; split ring.

3. Hangers for Cold Pipe Sizes two inches and over: Carbon steel, adjustable, clevis.

4. Hangers for Hot Pipe sizes two to four inch: Carbon steel, adjustable, clevis.

5. Hangers for Hot Pipe sizes six inches and over: Adjustable steel yoke, cast iron roll, double hanger.

6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

7. Multiple or Trapeze Hangers for Hot Pipe Sizes six inches and over: Steel channels with welded spacers and hanger rods, cast iron roll.

8. Wall Support: Welded steel bracket and wrought steel clamp.

9. Wall Support for Hot Pipe Sizes six inches and over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

10. Vertical Support: Steel riser clamp.

11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.

12. Floor Support for Hot Pipe Sizes up to four inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.

13. Floor Support for Hot Pipe Sizes six inches and over: Adjustable cast iron roll and stand, steel screws, and steel support.

14. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Refrigerant Piping:

1. Conform to ASME B31.5.

2. Hangers for pipe sizes 1/2 to 1-1/2 inch: Adjustable swivel ring, split ring.

3. Hangers for pipe sizes two inches and over: Carbon steel, adjustable, clevis.

4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

5. Wall Support: Welded steel bracket and wrought steel clamp.

6. Vertical Support: Steel riser clamp.

7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.

8. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel, threaded both ends, threaded one end, or continuous threaded.

B. Escutcheons: Nickel or chrome plate with screws or springs for holding plate in position.

C. Pipe Protection Saddles: Shop fabricate or purchase specially manufactured saddles specifically designed for the intended use. Provide saddles where roller type support is used, or where the pipe hanger is installed outside the insulation for protection of insulating jacket.

D. Outdoor applications: Metal components shall be galvanized.

2.3 INSERTS

A. Provide inserts to match the load bearing capacity of hangers scheduled in Part 3.

B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over four inches.

C. Concrete deck inserts: Galvanized rod, steel plate, similar to Kin-Line figure 293.

D. Screw insert for concrete: Malleable iron similar to Grinnell figure 152.

2.4 PRE-ENGINEERED SUPPORT SYSTEMS

A. Manufacturers:

1. Unistrut.

2. Super-Strut.

3. B-Line.

4. K-Line.

5. Erico.

B. Materials:

1. Cold worked steel.

2. Type 304 stainless steel: Use for PVC, liquid-tight flex, or plastic-coated conduit installed to wood construction in outdoor, damp, corrosive or marine environments.

C. Finish:

1. Heated indoor areas: Pre-galvanized zinc coating.

2. Outdoor areas: Hot dipped galvanized finish. In addition, coat hot dipped galvanized finish channel field cuts with zinc rich paint provide by the support system manufacturer.

3. Painted areas: Paintable galvanizing or phosphatized and primed.

4. Surface metal raceways: U.L. Listed epoxy coating.

D. Channel:

1. Standard Size: 1-5/8 inch x 1-5/8 inch. Gauge thickness as required for attached load.

2. Standard Hole Pattern: Slotted. Provide solid channel in exposed public areas.

E. Nuts and Hardware:

1. Channel nuts: Hardened steel (ASTM-A675 and ASTM A36).

2. Bolts, screws and nuts: Hardened steel (ASTM-A307, ASTM A563 and SAE J429).

3. Finish: Electroplated zinc.

F. Fittings: Plate steel (ASTM A635). Epoxy or electroplated zinc coating.

G. Mechanical Accessories: Provide accessories from the support system manufacturer designed for the specific equipment to be supported to include but not limited to:

1. Splice and gusset plates.

2. Corner angles.

3. Specialized support brackets.

4. Beam clamps with restraints.

5. Column supports.

6. Strut pipe clamps.

7. Straps.

8. Brackets.

2.5 SLEEVES, ACOUSTICAL SEALS AND FIRE-STOPPING

A. See Part 3 - PENETRATIONS.

B. Sleeves for pipes through fire rated and fire resistive floors and walls, and fire proofing: UL listed prefabricated fire rated sleeves and seals.

2.6 WALL/FLOOR PENETRATION WATER SEALS

A. Mechanical seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.

B. EPDM seals.

C. 316 Stainless steel bolts and nuts.

D. Hot-dipped galvanized or coated sleeve with full water stop flange with continuous weld on both sides.

E. Manufacturer: Metraflex, Thunderline, Crouse-Hinds, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in construction and under the supervision of a qualified installation supervisor.

3.2 PREPARATION

A. Prior to installation, prepare detailed shop drawings of the planned installation of hanger and support products specified by this section. Coordinate the location, type and size of hangers and supports, housekeeping pads (thickness/perimeter overhang dimensions) and roof curbs with Architectural and Structural elements utilizing the shop drawing review process.

B. Submit shop drawings required by this section coordinated with the seismic design and associated shop drawings required by Section 200548 - Mechanical Vibration and Seismic Control as a single submittal.

C. Do not install hangers and supports without approved shop drawings.

3.3 INSTALLATION

A. Special Techniques:

1. Install vibration isolators, seismic control and wind restraint systems in compliance with the manufacturer's written instructions and certified and approved application engineering installation drawings and details in accordance with Section 200548 - Mechanical Vibration and Seismic Control.

2. Insert and Attachment Installation:

a. Inserts:
   1). Provide inserts or cast-in-place channels for placement in concrete formwork.
   2). Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3). Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   4). Use expansion type anchor bolts with pre-cast concrete including concrete masonry units within loading limits of the pre-cast material and anchor bolt manufacturer's recommendations.
   5). Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
   6). Plastic screw inserts and caulked lead inserts are prohibited, except for mounting instructions and control diagrams.

b. Attach mechanical equipment to structure as follows:
   1). Hollow masonry: Toggle bolts.
   2). Solid masonry and concrete: Preset inserts or expansion bolts.
   3). Structural steel: Beam clamps which engage both sides of structural member or have retaining clips or other approved means for positive engagement.
   4). Metal surfaces: Machine screws, bolts or welding.
   5). Wood construction: Wood or sheet metal screws.
   6). Do not use powder-actuated fasteners for anchorage in tension applications. Obtain written permission from the Owner prior to using any type of powder powered studs.

3. Pipe Hanger and Support Installation:

a. Install hangers and supports in accordance with manufacturer's instructions, applicable Code requirements and approved shop drawings.
b. Support horizontal piping as scheduled.
c. Independently support piping at equipment, so that the equipment supports no weight.
d. Insulated piping shall have insulation saddles or 18 gauge steel insulation shields combined with sections of calcium silicate or cellular glass. Cold piping shall always be supported over the insulation and vapor barrier. Subject to approval, hot piping may be insulated around the supports.
e. Trapeze hangers shall be used when more than three pipes run parallel and at same elevation. Provide rollers for hot pipes. Design rods and cross members to support three times the weight of pipes and contents plus 250 pounds.

f. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
g. Place hangers within 12 inches of each horizontal elbow.
h. Use hangers with 1-1/2 inches minimum vertical adjustment.
i. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between hangers.
j. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
k. Support riser piping independently of connected horizontal piping.
l. Provide saddles where roller type support is used, or where the pipe hanger is installed outside insulation for protection of insulating jacket.
m. Piping requiring Vibration Isolation:
   1). Coordinate with Section 200548 - Mechanical Vibration and Seismic Control for piping requiring vibration isolation.
   2). Support main risers less than 20 feet in height only at mid-level, with riser guides at other levels.
   3). Do not support vibration isolated piping along with non-isolated piping on a common trapeze.
   4). Rigidly mount steel spring hanger boxes to the supporting structure. Do not locate in the middle of the hanger rod.
   5). Rigid pipe anchors are not permitted in vibration isolated piping circuits. When pipe anchors are required.

4. Equipment Bases and Support Installation:

   a. For cast-in-place concrete requirements refer to Division 3 - Concrete.
   b. Provide 5-1/2 inch (2x6 form) concrete housekeeping pads for floor mounted central air handling units. Coordinate perimeter overhang dimensional requirements (12 inches typical) with Section 200548 - Mechanical Vibration and Seismic Control, such that air handler anchor bolts achieve proper embedment.
   c. Provide 3-1/2 inch (2x4 form) concrete housekeeping pads for all other floor mounted mechanical equipment. Coordinate perimeter overhang dimensional requirements (8 inches typical) with Section 200548 - Mechanical Vibration and Seismic Control, such that equipment anchor bolts achieve proper embedment.
   d. Construct field fabricated equipment bases and supports from steel members and/or pre-engineered support systems. Prime and paint bases and supports black in accordance with Division 9 - Finishes. Pre-engineered support systems which are factory coated are not required to be painted.

5. Mechanical Equipment Installation:

   a. Provide hardware and accessories necessary to mount fixtures and equipment. Adapt to field conditions.
   b. Securely fasten fixtures and equipment to the building structure in accordance with the manufacturer's installation recommendations.
   c. Provide fabricated steel support frames and bases for equipment not directly mounted on floor. For belt driven equipment provide rigid structural base in common with motor to maintain belt tension.
   d. Provide steel base plates for floor mounted fixtures and equipment to distribute the weight such that the floor load is not more than 100 PSF, unless special structural reinforcement is submitted for approval.

e. At wall attached fixtures and equipment weighing less than 50 pounds, provide backing plates at least 1/8 by 10 inch square sheet steel or two by 10 inch fire retardant treated wood securely built into the structural walls. Submit attachment details of heavier equipment for approval.
f. Painted fabricated steel support black in accordance with Division 9 - Finishes.

6. Penetrations:

a. Coordinate mechanical penetrations with architectural and structural construction details prior to installation. Set sleeves in position in concrete formwork. Provide reinforcement around sleeves as required.
b. Provide compatible materials, fasteners, adhesives, sealants, and other products required for proper installation.
c. Provide penetrations through roof, exterior walls and floors (See floor penetration seals) to be weather and water tight.
d. Fire-Stopping: Provide UL rated fire-stopping assemblies for rated roof, wall and floor penetrations in accordance with Division 7.
e. Pipe and Duct Sleeves/Framed Openings:
   1). Provide sleeves for pipe and round ducts less than 16 inches diameter passing through floors, walls, ceilings, or roofs. Fabricate sleeves in non-load bearing walls from 20 gauge galvanized sheet steel conforming to ASTM A924 / A924M. Fabricate sleeves in load-bearing walls from standard-weight galvanized steel pipe conforming to ASTM A53 / A53M. Provide 1 inch clearance between the pipe or duct and sleeve opening. Oversize sleeves for cold piping to allow continuous insulation through sleeve.
   2). Provide framed openings for round ducts 16 inch diameter and greater and rectangular ductwork passing through floors, walls, ceilings, or roofs. Provide structural steel members for framed openings conforming to ASTM A36 / A36M. Provide 1 inch clearance between the duct and framed opening.
   3). Provide closure collars not less than 4 inches wide on each side of duct wall or floor penetration where sleeves or framed openings are provided. Fabricate collars for round and rectangular ducts with a minimum dimension less than 16 inches from 20 gauge galvanized steel. Fabricate collars for round and rectangular ducts with a minimum dimension of 16 inches or greater from 18 gauge galvanized steel.
   4). Provide escutcheons for piping and conduit passing through walls, floors and ceilings in finished areas, below counters and inside closets and casework subject to view when doors are open. Size escutcheons to cover sleeves. Secure escutcheons in position.

f. Acoustical Seals:
   1). Monolithic sound walls (i.e. poured concrete or masonry): Provide wall sleeve with approximately one-inch annular space around pipe. Pack annular space with backer rod or acoustical filler as specified in Division 7. Allow a 1 inch recess at each end of sleeve. Caulk sleeve flush with flexible sealant or firestopping material as specified in Division 7.
   2). Where acoustical wall is a two component type, such as a staggered or double stud partition, treat each component as a separate wall. Pack and seal each half of penetration sleeve as previously specified, except that only the exposed end of each sleeve portion can be caulked with sealant or fire-stop. Provide adequate separation between each sleeve.

g. Floor Penetration Seals:
   1). Provide pre-engineered floor penetration water seal systems for floor penetrations in rooms where a pipe leak/failure could result in water damage to adjacent spaces (i.e. mechanical rooms located above the ground floor or basement) and other areas as noted.
   2). Floor penetrations to include but not limited to: Building service piping, conduit, ductwork and building automation system wiring.
   3). Extend floor penetration sleeves 2 inches above finished floor.

7. Roof Flashing: Provide EDPM pipe penetration and roof curb flashing in accordance with Section 075000 - Single-Ply EDPM Membrane Roofing, as an integral part of the roofing system.

B. Interface with Other Work: Coordinate and sequence installation of hangers and supports with trades responsible for portions of this and other related sections of the Project Manual.

3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.5 SITE QUALITY CONTROL

A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

3.6 CLEANING

A. Waste Management: After construction is completed, clean and wipe down exposed surfaces.

3.7 TABLE

A. Pipe Support: Provide pipe support spacing as indicated in the table below except where spacing more restrictive by Code.

PIPE SIZE (Inches)	HANGER SPACING MAX (Feet)			
	Steel		Copper	Polyethylene (1)
	Water Filled	Gas Filled		
1/2	7	9	5	
3/4	7	9	5	

PIPE SIZE (Inches)	HANGER SPACING MAX (Feet)			
	Steel		Copper	Polyethylene (1)
	Water Filled	Gas Filled		
1	7	9	6	
1-1/4	7	9	7	
1-1/2	9	12	8	4
2	10	13	8	4-1/2
2-1/2	*11*	14	9	
3	12	15	10	5
4	14	17	12	6
6	17	21	14	
8	19	24	16	

(Based on Table 4, MSS SP-58, except for PE piping)

(1) (Based on manufacturer's data)

END OF SECTION 200529

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 200548 - MECHANICAL VIBRATION AND SEISMIC CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section specifies performance requirements for the design, furnishing, installation, supervision, and administration for all aspects of thermal expansion and contraction, vibration isolation, and seismic control of non-structural mechanical elements of the Project as shown on the drawings and/or specified in this and other Divisions for this nonessential facility. This is substantially a "performance" specification, unless otherwise noted.

2. It is the design intent to seismically anchor, brace, and support the facility's non-structural mechanical and electrical elements, including pre-engineered equipment, to the building's structure. This includes mechanical and electrical equipment, system piping and electrical raceways, tanks, vessels, flues, equipment racks, and cabinets, and equipment and assemblies that may be specified in other Divisions.

3. Seismic submittals, permits, and inspections required by the Authority Having Jurisdiction (AHJ) and this section shall be included.

B. Design Requirements:

1. Obtain the services of a specialized and qualified single source manufacturing and design firm (Seismic Design Firm) to design the overall vibration and seismic control restraint systems, including related thermal expansion and contraction control and wind effects, for the non-structural elements of this Project in accordance with the International Building Code (IBC) chapters 16 and 17.

2. Duties of the Seismic Design Firm include:

a. Specialized design, product review, and product selection.
b. Site verification and written certification that the installed vibration and seismic control and related products and systems meet the specialized design requirements.

3. Exceptions:

a. Pre-engineered seismically designed and certified assemblies in accordance with IBC, accompanied with written "Certificate of Compliance" acceptable to the Authority Having Jurisdiction, AHJ.
b. Pre-manufactured equipment designed in accordance with IBC accompanied with written "Certificate of Compliance" acceptable to the Authority Having Jurisdiction.

C. Related Divisions and Sections:

1. 019100 - Commissioning

2. Divisions 20, 21, 22, 23, 25 - Mechanical

3. Divisions 26, 27 and 28 - Electrical

1.2 RELATED WORK

A. Roof and wall structure supporting mounted equipment and hoods shall be designed for seismic and wind forces including, but not limited to tension, compression, and moment loads. The design shall comply with IBC requirements including load path to structure.

B. See Section 033000 - Cast-In-Place Concrete for housekeeping pad material and construction/attachment methods. Actual housekeeping pad locations, dimensions and through penetrations shall be coordinated with approved equipment base dimensions, weights, and anchoring requirements utilizing the product submittal and shop drawing process.

C. Coordinate with mechanical and electrical hanger and support specifications Section 200529 - Hangers and Supports, Section 233100 - Duct Accessories, and Section 260529 - Hangers and Supports for Electrical Systems, for related items of work and requirements.

D. Equipment, tanks, and related items attachment and concrete housekeeping pad embedment requirements shall be designed by the Seismic Design Firm in accordance with this section.

1. Housekeeping pads are typically sized for a minimum of 8-inch clearance all around the equipment or 12 times the anchor bolt diameter, whichever is greater.

2. Where exterior isolators are used, this distance is measured from the outermost holes in the isolator base plate to the edge of the housekeeping pad.

1.3 REFERENCES

A. Perform work in accordance with the legally enacted editions and amendments of the following codes and standards:

1. International Fire Code - 2012, IFC.

2. International Mechanical Code - 2012, IMC.

3. International Building Code - 2012, IBC.

4. Uniform Plumbing Code - 2015, UPC.

5. ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.

6. NFPA 13 - 2010, Installation of Sprinkler Systems.

7. NFPA 14 - 2010, Standpipes.

8. NFPA 70 - 2014, National Electric Code, NEC.

9. NFPA 101 - 2012, Life Safety Code

B. Provide materials, equipment, and installation methods which comply with the current standards of the following trade organizations:

1. American National Standards Institute - ANSI.

2. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE.

3. American Society of Mechanical Engineers - ASME.

4. American Society for Testing and Materials - ASTM.

5. Federal Emergency Management Agency - FEMA.

a. Installation of Seismic Restraints for Mechanical Equipment FEMA 412.
b. Installation of Seismic Restraints for Electrical Equipment FEMA 413.
c. Installation of Seismic Restraints for Duct and Pipe FEMA 414.

6. Institute of Electrical and Electronics Engineers - IEEE.

7. Insulated Cable Engineers Association - ICEA.

8. National Fire Code, National Fire Protection Association - NFPA.

9. National Electrical Manufacturers' Association - NEMA.

10. Underwriters Laboratories - UL.

11. VISCMA - Vibration Isolation and Seismic Controls Manufacturers Association.

1.4 DEFINITIONS

A. Essential Facilities: Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow, or earthquakes.

B. Life Safety and High Hazard:

1. Fire suppression systems, smoke control systems, fire alarm systems, and related actuated dampers, fans, and control panels.

2. Mechanical and electrical systems connected to and including emergency power generation equipment, transfer switches, transformers, and system components.

3. Any closed system containing toxic, corrosive, refrigerant, flammable, oxidizing, oxygen reduction, combustibles, flue gases, gas or liquid which poses a health hazard if released into the environment; High Hazard.

4. Medical and life support systems including medical gas equipment and piping.

5. Compressed Gases:

a. Any fixed tanks or piping containing hazardous, flammable, combustible, toxic, or corrosive materials, which include fuel gas, fuel oil, and gasoline.
b. Flammable, oxidizing, oxygen depletion, and/or combustible gases and fluids which shall be contained within a closes system (i.e. any gases which pose a health hazard if released into the environment, High Hazard).
c. Compressed gas piping.

C. General:

1. Anchor: A device, such as an expansion bolt, for connecting equipment bracing members to the structure of a building.

2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing analytical or inspection services, when such agency has been approved.

3. Attachment: See Positive Attachment below.

4. Basic Wind Speed: The basic wind speed (MPH) for determination of the wind loads shall be as per IBC or local code, if more severe. Local jurisdictions shall determine wind speeds for indicated special wind regions located near gorges or mountainous terrain.

5. Bracing: Metal channels, cables, or hanger angles that prevent components from breaking away from the structure during an earthquake or high winds. See also Longitudinal Bracing and Transverse Bracing. Together, they resist environmental loads from any direction.

6. Certificate of Compliance: A certificate stating that materials and products meet specified standards or that work was done in compliance with approved construction documents, provided by an approved agency.

7. Component: A non-structural part or element of an architectural, electrical, mechanical, plumbing, or fire suppression system within or without of a building system.

8. Component (Flexible): Component, including its attachments, having a fundamental period greater than 0.06 seconds.

9. Component (Rigid): Component, including its attachments, having a fundamental period less than or equal to 0.06 seconds.

10. Dynamic properties of piping: The tendency of pipe to change in weight and size because of the movement and temperature of fluids in them. This does not refer to movement due to seismic forces.

11. Equipment: Systems associated with ducts, pipes, and conduits also called components.

12. Failure: The discontinuance of any attachment point or load path between component and structure. Permanent deformation is acceptable as long as the component continues to operate without failure and if permanent, it is within acceptable manufacturing or structural tolerances.

13. Gas pipes: For the purposes of this specification, gas pipe is any pipe that carries fuel, gas, fuel oil, medical gas, compressed air, or refrigerants.

14. Hazardous Contents: A material that is highly toxic, potentially explosive, or corrosive and in sufficient quantity to pose a significant life-safety threat to the general public if an uncontrolled release were to occur.

15. High Hazard System: Any system handling flammable, combustible, or toxic material or other hazardous contents.

16. Inspection Certificate: An identification applied on a product by an approved agency containing the name of the manufacturer, the function and performance characteristics, and the name and identification of an approved agency that indicates that the product or material has been inspected and evaluated by an approved agency.

17. Ip, Component Importance Factor: A factor (typically 1.0 or 1.5) for calculating seismic forces on non-structural supports.

18. Label: Identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics, and the name and identification of an approved agency that indicates that the representative sample of the product or material has been tested and evaluated by an approved agency.

19. Lateral forces: Force acting on a component in the horizontal plane. This force can be in any direction.

20. Life Safety Components: Components required for the continued operation of the facility and whose failure could impair the facility's continued operation regardless of the governing Code.

21. Longitudinal bracing: Bracing that prevents a component from moving in the direction of its run.

22. Longitudinal force: An applied force that happens to be in the same direction as the duct or pipe run.

23. Mark: Identification applied on a product by the manufacturer indicating the name of the manufacturer and the function of a product or material.

24. Manufacturer's Designation: Identification applied on a product by the manufacturer indicating that a product or material complies with a specified standard or set of rules.

25. NRCA: National Roofing Contractors Association.

26. Occupancy Category: A classification used to determine structural load requirements including those imposed by wind, flood, snow, and seismic based on occupancy of the structure.

27. Positive Attachment: A mechanical device, designed to resist seismic forces, which connects a non-structural element, such as a duct, to a structural element, such as a beam. Bolts and welding are examples of positive attachments. Surface glue and friction anchorage do not constitute positive attachment. Examples of positive attachment are epoxy cast in anchors and drill in wedge shaped anchor bolts to concrete and welded or bolted connections directly to the building structure. Double-sided beam clamps, C type

are not acceptable as either brace point attachments to the structure or for the support of the component at the bracing location.

28. Periodic Special Inspection (PSI): See Special Inspection (Periodic).

29. Seismic: Related to an earthquake. Seismic loads on a structure are caused by wave movements in the earth during an earthquake.

30. Seismic Design Category: A classification assigned to a structure based on its Seismic Use Group or Occupancy Category and the severity of the design earthquake ground motion at the site.

31. Seismic Forces: The assumed forces prescribed herein, related to the response of the structure to earthquake motions, to be used in the design of the structure and its components.

32. Site Class: A classification assigned to a site based on the types of soils present and their engineering properties as defined in IBC.

33. Special Inspection (SI): Inspection as herein required of the materials, installation, fabrication, erection, or placement of components and connections requiring special documents and referenced standards.

34. Special Inspection (Continuous): The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

35. Special Inspection (Periodic) (PSI): The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.

36. Story Drift Ratio: The story drift (Lateral displacement) divided by the story height.

37. Transverse Bracing: Bracing that prevents a component from moving from side to side.

1.5 SYSTEM DESCRIPTION AND CRITERIA

A. Design Requirements:

1. Provide vibration isolation, seismic control, anchoring, system products, and application design and installation supervision services from a single pre-approved product manufacturer and a Seismic Design Firm.

2. Provide design to anchor, brace, and support the facility's non-structural elements, including pre-engineered equipment, to the building's structure. Provide all secondary structural elements to support, anchor, and transfer loads to the building structure. This includes mechanical and electrical equipment, tanks and vessels, system piping, and electrical raceways.

B. Building Design Criteria:

1. Wind design data: See Structural Drawing.

2. Seismic design data: See Structural Drawing.

3. Component Importance Factors, Ip:

   a. Life Safety Components, including fire suppression systems: Ip = 1.5
   b. Components containing High Hazardous materials: Ip = 1.5
   c. Mechanical and Electrical Equipment and Systems: Ip = 1.0
   d. All other components: Ip = 1.0

C. Performance Requirements:

1. Design seismic restraint devices to accept the detailed forces acting through the equipment's center of gravity for the non-structural components of the project; this includes pad mounted and equipment exterior to the building envelope.

2. Responsibilities of the Seismic Design Firm include:

   a. Professional structural engineering calculations, drawings, and details to show the restraint of non-isolated equipment.
   b. Determination of vibration isolation and restraint product sizes and locations.
   c. Supply and delivery of vibration isolation and seismic restraint products.
   d. Provision of installation instructions, detailed shop drawings, and trained field supervision to insure proper installation and performance for work under this Section.
   e. Review and approval or rejection of Certificates of Compliance from Original Equipment Manufacturers (OEM) furnishing seismically designed pre-engineered equipment or assemblies.
   f. Certification of the correctness of installation upon completion.

3. Equipment with factory mounted internal vibration and seismic restraint devices shall meet the vibration and seismic control requirements of this section. In addition, the approved seismic design engineer shall review and approve the equipment's factory mounted internal vibration and seismic restraint devices and submit a written approval letter accompanying the equipment's initial product submittal for approval by the Contracting Agency.

4. In the event that the equipment is internally isolated and restrained, the entire unit assembly shall be seismically attached to structure.

5. Seismic and wind attachment between the equipment and the curb, rail, post, or concrete pad.

1.6 VIBRATION AND SEISMIC CONTROL DESIGN

A. Seismic and Wind Load Certification and Analysis:

1. Prepare and submit professional structural engineering sealed calculations, drawings, and details substantiating the mounting system, seismic and/or wind restraints, and recommended anchor bolts for each piece of mechanical and electrical equipment will accept anchorage, through the component's load path to structure at its center of gravity, at the designated anchorage locations. Details and calculations shall include attachment to building structure or exterior pad. Show evidence of coordination with the structural engineer of record.

2. Calculations and supporting documents to clearly show assumptions, materials, dimensions, abbreviations, code references and formulas, force diagrams, and results intermediate steps to validate conclusions without the use of a computer program by the reviewer.

3. Design seismic loads.

4. Design wind loads.

5. Engineering calculations, drawings, and details, and product information shall be submitted to and approved by the Authority Having Jurisdiction and the structural Engineer of Record.

B. Design Seismic Loads:

1. Calculate loads for both internal or external isolation and/or anchorage of components for the actual project location. Calculations to include minimum design loads and minimum horizontal and vertical restraint capability.

2. Analysis for anchorage to include:

a. Calculated dead loads.
b. Static seismic loads.
c. Material strength of anchoring material (system).
d. Load transfer to adequate structural members.
e. Detail of anchoring methods including:
   1). Bolt diameter.
   2). Embedment and/or welded depth, length, and type.

C. Design Wind Loads:

1. Positively fasten outdoor mounted components to their supporting structure(s) to prevent failure due to wind load.

2. If equipment is mounted to a pre-engineered or field fabricated support bracket, provide positive attachment through welding or bolting of equipment to the support system.

a. Base loads and calculations on IBCand related ASCE sections.
b. Base equivalent IBC basic wind speed.

c. Do not de-rate calculated wind load on outdoor equipment due to adjacent buildings, structures or screens.

1.7 SUBMITTALS

A. Submittals shall be complete for review. Section submittal log to be the first section submitted along with Seismic Design Letter of Intent and related contractor's responsibility and section forms. Drawings, calculations, and products shall be complete and submitted together in one package. See Section 200000 - General Mechanical Requirements for additional requirements not covered below.

B. Provide one hard copy of submittal for engineer's use. Provide an electronic copy of each submittal in PDF format with bookmarks matching table of contents, including shop drawings with each required paper, hard copy, submittal. Electronic Submittals shall generally follow the organization and formatting required for paper submittals. Provide electronic bookmarks within PDF file in place of tabs and sub-tabs. If individual PDF files are provided for each product or shop drawing sheet, organize files into folders and name files and folders to correspond with applicable specification sections or drawing titles.

C. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Contract Documents.

D. Product Data:

1. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.

2. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

3. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and restraints by referencing numbered descriptive drawings.

4. California Office of Statewide Health Planning and Development, OSHPD, bracing systems having a current anchorage preapproval "OPA" number shall be submitted with information on usage and capability to resist seismic forces noted as applicable when used for this project.

E. For Seismic Design Categories C thru F:

1. For Life Safety Components: Submit approved agencies Analytical or Shaker Test “Certificate of Compliance” certification. Analytical or Shaker Test through the component’s load path including structure at its center of gravity shall include anchorage, structural and online capability.*

2. Components Needed for the Continued Operation of the Facility: Submit approved agencies Analytical or Shaker Test “Certificate of Compliance” certification. Analytical or Shaker Test through the component’s load path including structure at its center of gravity shall include online capability.*

3. Components Containing Hazardous or Flammable Materials: Submit approved agencies Analytical or Shaker Test “Certificate of Compliance” certification. Analytical or Shaker

Test through the component's load path including structure at its center of gravity shall include anchorage, structural, online capability and hazardous material containment.* Testing shall prove that no internal component will rupture to insure against loss of hazardous or flammable (explosive) material which could support combustion, ignite or contaminate.

4. * Use of historical data is permitted if evidence confirms historical based component having the same construction and weight with accompanying center of gravity as the submitted unit and basis of historical claim conforms to loads derived in testing with accompanying accelerations based on AC-156, "Acceptance Criteria for Seismic Certification by Shake-table Testing of Nonstructural Components".

5. Components not listed and requiring only anchorage and load transfer compliance. Seismic design engineer shall submit professional engineer sealed engineering calculations, drawings, and details to support the project specific equipment will accept anchorage through the component's load path to structure at its center of gravity, at the designated anchorage locations.

F. Engineering Calculations:

1. Submit by a qualified Alaskan structural engineer sealed engineering calculations, drawings, and details to support the product selection and installation configuration for each vibration and seismic control restraint application.

2. Show evidence of coordination with the structural Engineer of Record.

3. Coordination and approval of non-structural element attachment techniques and design loads with the project's structural design Engineer of Record.

G. Substitutions:

1. Equipment manufacturers' substitution of internally or externally isolated and/or restrained equipment supplied by the equipment vendor, in lieu of the isolation and restraints is acceptable provided design conditions of this Section are met.

2. The equipment manufacturer shall provide a letter of guarantee from their Engineering Department, with professional engineer stamped and certified stating that the seismic restraints are in full compliance with these specifications. Letters from field offices or representatives are unacceptable.

3. Where used on an Essential or High Hazard Facility manufacturer's certification proving on line capability shall also be required. Letters from field offices or representatives are unacceptable.

4. Costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment vendor in the event of non-compliance.

H. Shop Drawings:

1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

2. Provide details of suspension and support for ceiling hung equipment.

3. Where walls, floors, slabs, or supplementary steel work are used for restraint locations, details of acceptable attachment methods shall be included and approved before the condition is accepted for installation.

4. Restraint manufacturer's submittals shall include spacing, and maximum static loads and seismic/wind loads at attachment and support points.

5. Indicate the type and location of piping hangers, equipment supports, seismic movement, and seismic restraints.

6. Building seismic joints and/or displacement at each level.

7. Provide specific details of restraints and anchor including number, size and locations for each piece of equipment. Annotate coordination requirements for topping slabs and embedded mechanical or electrical systems; example: radiant tubing, conduit, and sensors.

I. Quality Assurance and Control Submittals:

1. Contractor's Quality Assurance and Quality Control procedures for the administration and tracking of special inspections and testing.

2. Design Data and Test Reports.

3. Certificates and Manufacturer's Instructions.

4. Vibration and Seismic Control Product Manufacturer/Applications Engineering firm qualifications.

5. Seismic design firm's qualifications and E&O insurance certificate.

6. Seismic design engineer's professional license and seismic engineering qualifications.

7. Authority Having Jurisdiction submittal review comments and final approval notification.

8. Manufacturer's Field Reports.

9. Written verification of training.

10. Seismic Design Firm's Certification of the correctness of completed installation.

J. Review, Approvals, and Permits Required

1. Obtain written review and/or approval of from the following:

a. Contracting Agency - (Approval).
b. Authority Having Jurisdiction, AHJ - (Approval).
c. Architect - (Review).
d. Mechanical Engineer - (Review).
e. Electrical Engineer - (Review).
f. Structural Engineer - (Approval).

2. Comply with the above review comments, revising the design as required, and resubmitting in a timely manner, so as not to hinder the construction schedule.

3. Obtain and pay for required permits, inspections, tests, and approvals as required by Authority Having Jurisdiction.

K. Operation and Maintenance (O&M) Manual:

1. Provide a copy of the manufacturer's written installation, operation and maintenance manual to include the following information:

a. Manufacturer's descriptive literature neatly annotated to indicate information applicable to the equipment installed.
b. Certified seismic design calculations and installation details.

L. Close-out Submittals:

1. Project record drawings: Annotate a clean copy of the project Contract Drawings to indicate the actual installation location of each vibration and seismic restraint device type and keyed to the appropriate installation detail.

2. Provide a certificate from the seismic design firm indicating that the vibration and seismic restraint systems of the facility are installed and operational as designed.

1.8 QUALITY ASSURANCE

A. Manufacturer qualifications: Company specializing in manufacturing the products specified in this section with a minimum of five years documented experience.

B. Installers' qualifications: Minimum five years of experience in the installation of specialized vibration and seismic control systems.

C. Seismic Design Firm: Minimum five years of experience in the design, selection, and inspection of specialized seismic control systems for facilities with similar Occupancies and seismic criteria and acceptable to the Authority Having Jurisdiction. Liability insurance and professional Errors and Omissions insurance for engineering services provided.

D. Seismic Design Engineer: Alaska licensed professional structural engineer. Engineer shall have a minimum of 5 years of documented seismic engineering experience and acceptable to the Contracting Agency and the Authority Having Jurisdiction.

E. Errors and Omissions Insurance Certificate:

1. Submit copy of seismic design firm's insurance certificates.

2. Product liability insurance certificates are not acceptable.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:

1. Verify vibration isolator/seismic restraint components are delivered in original factory packaging/crating and are free from damage and corrosion.

2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Contracting Agency.

B. Storage and Protection:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

2. Handle items to avoid damage.

3. Replace damaged items with same item in new condition.

1.10 WARRANTY

A. Provide warranty in accordance with Division 1 requirements.

B. Warranty workmanship, labor, and materials for a period of one year from the date of final acceptance, without limitation, except where longer warranty periods are specified in a specific Section under this Division, or in the General Conditions of the Contract. Promptly coordinate and perform Warranty work at the Contractor's sole expense.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Materials and devices shall be in accordance with applicable codes and standards and shall be appropriate for intend uses.

B. Provide vibration isolators and seismic restraint products for the project from the same manufacturer.

C. Provide vibration and seismic application engineering design services from the same manufacturer as the products or from an approved Alaska licensed professional structural engineer.

2.2 MANUFACTURERS

A. Approved Manufacturers, substitutions by prior approval only. Subject to compliance with requirements, provide products by one of the named manufacturers. Substitutions will be considered for products by other manufacturers if submitted in advance of bidding in conformance with Division 1 requirements.

1. Amber Booth (AB).
2. Cooper B-Line.
3. Flex Hose.
4. Hilti.
5. International Seismic Application Technology (ISAT).
6. Kinetics Noise Control.
7. Korfund Dynamics.
8. Loose & Company.
9. Mason Industries.
10. Metraflex.
11. Thybar.
12. Tolco.
13. Unistrut, Tyco International.
14. Vibration Mountings & Controls (VMC).
15. Vibro-Acoustics.
16. Other: Pre-Approved.

2.3 PRODUCT CATEGORIES

A. Provide product submittals in the following categories with specific product and application identified:

1. Vibration Isolation.
2. Seismic Restraint.
3. Equipment Bases and Curbs.
4. Flexible Connectors.

2.4 FINISHES

A. Provide finishes for corrosion protection:

1. Exposed steel to be finished with dry powder coating for corrosion protection, galvanized, or stainless steel.

2. Hardware shall be zinc electroplated, galvanized, or stainless steel. Hardware in contact with concrete and surfaces subject to liquids shall be stainless steel.

3. Springs and housings shall be powder coated.

B. In public areas exposed systems and elements shall be painted, excluding dynamic assemblies that shall have manufacturer's coating:

1. Clean and prepare pipe, fittings, hangers, restraints, supports, and miscellaneous items for areas to be painted.

2. Refer to the requirements specified in Division 9.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Visually inspect each location that will receive equipment and systems requiring vibration, thermal compensation, seismic control and/or wind load bracing for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement, pre-placed anchors, and cast-in-place anchors to verify actual locations before installation.

C. Correct deficiencies prior to the installation.

3.2 GENERAL INSTALLATION REQUIREMENTS FOR VIBRATION ISOLATION, SEISMIC CONTROL, AND WIND RESTRAINT SYSTEM COMPONENTS

A. Install vibration isolators, seismic control, and wind restraint systems in compliance with the manufacturer’s written instructions, and certified and approved application engineering installation details.

B. Install vibration isolators, seismic control, and wind restraints so as not to stress or misalign equipment, piping, raceways, and ductwork.

C. Provide flexible connections for conduit, ducts, and piping for vibration isolated equipment.

D. Coordination installation to not degrade acoustical penetrations and vibration controls for ducts, pipes, and raceways.

E. Do not install rigid connections between isolated equipment and building structure that degrades the noise and/or vibration controls.

F. Submit equipment loads for pre-approval by the project Structural Engineer prior to equipment installation to avoid overstressing of the building structure. Coordinate seismic restraints with project Structural Engineer and incorporate requirements.

G. Seismic restraint systems shall not interfere with installation or maintenance access to other building systems.

H. Provide general bracing from structural beam flanges, upper truss cords in bar joist construction, cast in place inserts, or wedge type drill-in concrete anchors.

I. Restraining straps or J-bolts shall be used as secondary restraint on beam clamps that support dead loads. Beam claps lacking secondary restraint features shall not be used.

J. Install seismic cable assemblies taut on non-vibration isolated systems and with a slight amount of slack for vibration isolated systems to avoid short circuiting of isolated equipment and piping.

K. Seismic single arm braces may be used in place of cables on rigidly attached systems and in place of cables on isolated systems when resilient bushings are used.

L. At locations where seismic cable restraints or seismic single arm braces are located, brace support rods per manufacturer's recommendations to accept loads.

M. At locations where seismic cable braces and seismic cable restraints are attached to pipe clevis hangers, reinforce the clevis hanger bolt with cross bolt braces or double inside nuts if required for the specific seismic acceleration levels.

N. Provide integral vibration isolation structural steel bases as specified when required. Independent steel rails are not permitted.

O. Conduct Special and Periodic Inspections for work under this section and submit reports in a timely basis; a maximum of 2 working days between site inspection and receipt of written report.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections or design accommodations in pipes, ducts, and raceways 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.

3.4 INSTALLATION OF EQUIPMENT

A. Isolate and/or restraint equipment in accordance with manufacturer's recommendations.

B. Concrete pads. Install base mounted equipment on reinforced concrete housekeeping pads or reinforced concrete pads for exterior equipment properly sized and doweled or expansion

shielded to the deck to meet acceleration design criteria. Extend pads beyond equipment base rails/floor mounting plates to meet anchor embedment requirements. Anchor equipment to housekeeping pads in accordance with certified and approved anchoring details.

C. Install equipment bases into position (at operating height of the isolators) using temporarily supported blocks or shims prior to the installation of the equipment, isolators and restraints:

1. After the installation is complete and under full load (i.e. equipment filled with operating fluid), adjust isolators to transfer load from the temporary blocks to the isolators.

2. Remove blocks, shims and debris from beneath the equipment and verify that there are no short circuits of isolation. Verify the equipment is free move in all directions, within the limits of the restraints.

3. Minimum operating clearance under isolated equipment is 2 inches.

D. Protect air handling equipment and centrifugal fans from excessive displacement resulting from air thrust in relation to equipment weight. Provide horizontal thrust restraints when horizontal motion exceeds 3/8 inch.

E. Provide earthquake ceiling clips or other approved means of positive attachment of ceiling lighting fixtures, less than 75 pounds, to the ceilings T-bar support grid. Where ceilings are not braced, provide lay-in lighting fixtures with 4 independent corner diagonal wire ties to structure.

F. Restrain floor and wall mounted equipment and tanks with Type V restraints.

3.5 INSTALLATION OF PIPING, DUCTWORK, AND ELECTRICAL RACEWAYS SEISMIC RESTRAINT

A. Seismic restraint is not required for mechanical and electrical components in Seismic Design Category D where component importance factor, Ip, is equal to 1.0 and either:

1. Flexible connections between the components and associated ductwork, piping, and conduit are provided.

2. Components are mounted at 4 feet or less above a floor level and weigh 400 pounds or less.

B. High Hazard and Life Safety Systems; Ip, is equal to 1.5:

1. Seismically restrain High Hazard and Life Safety Systems regardless of piping diameter, etc. No exclusions for size or distance in this category.

2. Other non-excluded systems include, but are not limited to:

a. Any fixed tanks or piping containing hazardous, flammable, combustible, toxic, or corrosive materials, which include fuel gas, fuel oil, and gasoline.
b. Fire pump and associated equipment, fire suppression mains and risers.
c. Flammable, oxidizing, oxygen depletion, and/or combustible gases and fluids which shall be contained within a closes system (i.e. any gases which pose a health hazard if released into the environment are High Hazard).

d. Electrical: Critical, standby or emergency power components including conduit (1 inch diameter and larger) raceways, lighting, fire alarms, panels, and communication lines involving 911, etc.
e. Ductwork: Emergency generator exhaust; fuel fired venting, breeching, and stacks; toxics; and flammable gases.

3. For fuel oil and fuel gas piping, provide transverse restraints at 20 foot maximum intervals and longitudinal restraints at 40 foot maximum intervals.

C. Piping, Conduit, Bus Duct, and Electrical Raceways:

1. Piping/conduit located in boiler rooms, fan rooms and other mechanical rooms that is 1-1/4 inch diameter and larger:

2. Piping/conduit located in the remaining areas of the building that is 2-1/2 inch diameter and larger:

3. Piping passing through two-sided sheetrock walls: If the sheetrock penetration is tight to the pipe, the penetration may act as the lateral/transverse brace for pipe sizes up to and including 4 inches provided the hole is reinforced with metal corner beading.

4. Underground Utility Piping: For horizontal underground utility piping passing through foundation walls, provide oversized and sleeved foundation wall openings waterproofed to accommodate maximum allowable building drift and differential movement.

D. Ductwork:

1. Chimneys, flues, and boiler breeching:

a. Bolt chimney, flues, and boiler breeching assemblies passing through floors at each floor level or secure above and below each floor with riser clamps.
b. Provide pre-engineered chimney/stack systems with seismic support assemblies as part of the integrated system when possible or separate engineered system.

2. Restrain rectangular, round, and flat oval ductwork (of the same nominal size) with cross sectional area of 6 square feet (33 inch diameter) or larger.

3. Brace ductwork serving a life safety function or carrying toxic materials in an “Essential or High Hazard Facility” with no exceptions and regardless of duct size or length requirements.

4. Reinforce ductwork at each restraint location with an additional angle on top of the ductwork attached to the support hanger rods. Attach the ductwork to both upper angle and lower trapeze. Additional reinforcement is not required if duct sections are mechanically fastened together with frame bolts and positively fastened to the duct support suspension system.

5. At duct locations supported by angles, channels or strut and requiring seismic restraint, connect seismic bracing to support in lieu of duct reinforcement.

6. A group of ducts may be combined in a single larger frame if the weights and dimensions of the smaller combined ducts are less than or equal to the maximum weight and dimensions of the duct for which the bracing system was designed.

7. Walls with duct penetrations, including gypsum board non-bearing partitions, may be used as a typical transverse duct brace if the penetration is framed with steel channel and the void space between the channel and duct is filled with blocking.

8. Components that are installed in-line with the duct system and have an operating weight greater than 75 pounds (silencers, coils, dampers, fans, heat exchangers, humidifiers) shall be supported and laterally braced independent of the duct system.

9. Unbraced piping attached to in-line equipment shall be provided with adequate flexibility to accommodate the seismic relative displacements.

10. Appurtenances less than 75 pounds such as dampers, louvers, and diffusers shall be positively attached with mechanical fasteners.

3.6 EXCLUSIONS

A. Seismic restraint is not required for mechanical and electrical components in Seismic Design Category C where component importance factor, Ip, is equal to 1.0.

B. Seismic restraint is not required for the following:

1. Mechanical and electrical components in Seismic Design Category D, E, or F where all of the following apply:

   a. The component importance factor, Ip, is equal to 1.0;
   b. The component is positively attached to the structure, no free-sliding equipment;
   c. Flexible connections are provided between the components and associated ductwork, piping, and conduit and either:
      1). The component weighs 400 pounds or less and has a center of mass located 4 feet or less above the adjacent floor level or
      2). The component weighs 20 pounds or less, or 5 pounds/foot or less for distributed systems.

2. Conduit, Cable Tray, and Other Electrical Distribution System Raceways:

   a. Conduit less than 2-1/2 inches in diameter.
   b. Trapeze assemblies to support raceway less than 10 pounds/foot.
   c. Raceway supported by hangers less than 12 inches from support point to the support structure. Rod hangers shall be equipped with swivels to prevent inelastic bending of the rod.

3. HVAC Ductwork when the following conditions are met for the full length of each duct run where provisions are made to avoid impact with larger ducts or mechanical components or to protect ducts in the event of such impacts and:

a. Rectangular, square, and oval ventilation ductwork less than six square feet (33 inch diameter) in cross sectional area, or weigh 17 lb/ft or less.
b. Ductwork supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork. Hangers detailed to avoid significant bending of the hangers and their attachments.

4. Piping Systems, excluding elevator piping:

a. Trapeze assemblies to support raceway less than 10 pounds/foot and either, for Seismic Design Categories D, E, or F:
1). Ip =1.0 the nominal pipe size is 3 inches or less, or
2). Ip greater than 1.0 the nominal pipe size is 1 inches or less.

b. Piping supported by hangers and trapeze less than 12 inches from support point to the support structure. Rod hangers shall be equipped with swivels to prevent inelastic bending of the rod.

3.7 CONSTRUCTION

A. Interface with other Work:

1. Coordinate and sequence installation of vibration, seismic control, and wind load bracing with trades responsible for portions of this and other related sections of the Project Manual.

2. Rework required as a result of failure to follow the manufacturer's written installation instructions or properly coordinate with related Work shall be completed at no additional expense to the Contracting Agency.

3. Coordinate and schedule special and periodic inspections related to systems under this specification section.

3.8 REPAIR/RESTORATION

A. Repair product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.9 FIELD QUALITY CONTROL

A. Document each installation and operational step to show compliance with this Section utilizing the approved PC/FT checklists in accordance with Section 019100 – Commissioning.

B. Special Inspections:

1. Independent Special and Periodic Inspections shall be performed and written reports submitted for the specific components as indicated at the expense of the Contracting Agency.

2. Special Periodic Inspections: The following systems shall require Special Inspection (SI) and Periodic Special Inspection (PSI) for seismic installation and anchorage during the course of construction for buildings in Seismic Design Categories C-F:

    a. Electrical components for standby or emergency power systems (PSI).
    b. Flammable, combustible, and highly toxic piping and their associated mechanical systems (PSI).
    c. Ductwork and flues containing hazardous materials (PSI).
    d. Equipment using combustible or toxic energy sources (SI).
    e. Electric motors, transformers, switchgear unit substations and motor control centers (SI).
    f. Reciprocating and rotating type machinery (SI).
    g. Piping systems three (3) inch diameter and larger (SI).
    h. Tanks, heat exchangers and pressure vessels (SI).
    i. Isolators for seismic isolation systems (PSI).

C. Manufacturer's Field Services:

1. Upon completion of installation of vibration isolation/seismic restraint devices and systems, the vibration isolator/seismic restraint manufacturer's qualified representative shall inspect the completed project and certify in writing to the Contractor that systems are installed properly or provide detailed corrective action required.

2. If corrections are required, additional inspections shall be completed at by the manufacturer's representative no additional cost to the owner until the work is installed properly and certified.

3. The Contractor shall submit a report to the Contracting Agency that includes the manufacturer's qualified representative letter certifying correctness of the installation.

D. Seismic Design Firm:

1. Site verification and written certification installation is per submitted documents and completed.

2. Include photo of completed installation of equipment with tag ID annotated installed isolators and restraints, and typical installation with location annotated for ducts, pipes, and raceways.

3.10 CLEANING

A. Upon completion of installation remove construction debris from around vibration isolated and seismically restrained components to allow free motion in all directions within the limits of the seismic restraining devices.

3.11 EQUIPMENT STARTUP

A. During equipment start-up, verify proper installation and operation of associated vibration isolators and seismic restraints as applicable.

3.12 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

D. Adjust vibration isolators and seismic restraints during equipment operation to minimize the transmission of equipment sound and vibration through the building structure and attached ductwork and piping systems.

E. Allow for thermal compensation.

END OF SECTION 200548

SECTION 200553 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Equipment Nameplates.
2. Valve Tags.
3. Valve and Equipment Directories.
4. Pipe Identification.
5. Ceiling Markers.
6. Painting of bare and insulated piping systems.

B. Related Sections:

1. 200000 - Mechanical General Requirements
2. 221100 - Domestic Water Piping and Specialties
3. 221300 - Sanitary Waste and Vent Piping and Specialties
4. 231113 - Fuel Oil Piping and Specialties
5. 231323 - Aboveground Fuel Oil Storage Tanks
6. 232113 - Hydronic Piping and Specialties
7. 232123 - Hydronic Pumps
8. 233100 - Ducts and Accessories
9. 233400 - HVAC Fans
10. 233600 - Air Terminal Units
11. 235223 - Cast Iron Boilers and Accessories
12. 236400 - Packaged Water Chillers
13. 237323 - Central Air Handling Units
14. 238123 - Dedicated Air-Conditioning Units

15. 238200 - Terminal Heating and Cooling Units

16. 238316 - Radiant Floor Heating Equipment

17. 254000 - Variable Speed Drives

1.2 REFERENCES

A. Codes and Standards:

1. ANSI/ASME A13.1-2007 (American Society of Mechanical Engineers) - Scheme for the Identification of Piping Systems.

2. ANSI Z535.1-2006 (R2011) - Safety Color Code.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Provide equipment nameplates, valve tags and labels for the mechanical systems provided under this contract.

2. Provide labels for piping. Paint exposed piping and pipe insulation in utility and mechanical rooms.

1.4 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Master Schedule of Equipment:

a. Submit master schedule of equipment, components, and systems that will be tagged and labeled for the project.
b. Include the proposed method of labeling to be implemented (nameplate, tag, label/marker, etc.), legend (“Domestic Cold Water,” “PMP-1,” etc.) and letter/background colors.
c. Match legend to Contract Document legend, abbreviations, and schedule symbols. Use standard mechanical identification products when available.

2. Equipment Directories: Submit separate proposed “Equipment Directories” (subset of the master schedule) for each mechanical room that includes the equipment located within the applicable space. Include system name, fluid or medium type, and normal operating properties and ranges.

3. Valve Directories: Submit separate proposed “Valve Directories” (subset of the master schedule) for each mechanical room that includes the valves located within the applicable

space. Include valve designations, a brief description and normal position (open (NO), closed (NC), balanced to X GPM). For Example:

Valve Designator	Description	Normal Position
H-101	BLR-1 Supply Isolation	NO
H-102	BLR-1 Return Isolation	NO
H-103	BLR-1 Flow Balance	150 GPM
P-100	Domestic Water Service Isolation	NO
P-201	Supply Strainer Flush Valve	NC
ETC.		

C. Installation, Operation and Maintenance (IO&M) Manuals:

1. Provide completed, typed “Master Schedule of Equipment.”

2. Provide completed, typed “Equipment Directories.”

3. Provide completed, typed “Valve Directories” with balance valve settings obtained from the final balance report.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Marking Services Incorporated (MSI).

B. Seton Identification Products.

C. Craftmark.

D. Approved equal.

2.2 EQUIPMENT NAMEPLATES

A. Plastic Engraved Equipment Nameplates:

1. Minimum letter height: 3/4 inch.

2. Tag size: Minimum 2 inches high, length to fit equipment tag lettering requirements. Provide uniform size for similar types of equipment.

3. Plastic thickness: 1/16 inch minimum.

4. Fastening method:

a. Mounting holes.
b. Adhesive backing may be provided for labeling equipment where drilling holes is not feasible, with the pre-approval of the Contracting Agency.

5. Color coding: As designated by the Contracting Agency. If specific direction is not provided, select white letters on black background.

6. Legend: As designated by the Contracting Agency. If specific direction not provided, match scheduled equipment symbols.

2.3 VALVE TAGS

A. General:

1. Small equipment, such as in-line pumps may be identified with tags in lieu of nameplates if inadequate room is available.

2. Provide service indicator on top line of tag, using system abbreviations provided in Part 3 Pipe Identification Table.

3. Provide valve number on bottom line of tag. Start valve numbering with “001” for each legend series/service indicator. Assign valve numbers in a logical sequence from the source (i.e. service water entry point, gas meter service isolation) or heat source (boiler or water heater supply) and continue numbering outward to the most remote terminal connection point.

B. Plastic Engraved Tags:

1. Round, 1-1/2 inches diameter, engraved plastic.

2. Text stamped and filled black:

a. 1/4 inch service indicator on top.
b. 1/2 inch valve number below.

3. Beaded chain tag fasteners.

4. Provide tag color coding to match pipe marker coding or as designated by the Contracting Agency.

C. Brass Stamped Tags:

1. Round, 1-1/2 inches diameter, brass with smooth edges.

2. Text stamped and filled black:

a. 1/4 inch service indicator on top.
b. 1/2 inch valve number below.

3. Beaded chain tag fasteners.

2.4 VALVE AND EQUIPMENT DIRECTORIES

A. Equipment and Valve Directory Frame:

1. 8-1/2” x 11” aluminum frame with plastic lens.

2. Provide multiple frames as required.

2.5 PIPE IDENTIFICATION, MARKING

A. Identify both service and flow direction.

B. Colors and Lettering: Conform to ANSI/ASME A13.1; see tables under Article 3.2E below.

C. Plastic Pipe Labels:

1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering.

2. Larger sizes may have maximum sheet size with plastic nylon ties or straps.

D. Plastic Tape Pipe Labels: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.6 CEILING MARKERS

A. Description:

1. 7/8-inch diameter, color-coded.

2. Metal push tacks or 0.030” rigid vinyl, pressure sensitive stickers.

B. Color code as follows:

1. HVAC equipment: Yellow.

2. Plumbing valves: Green.

3. Non potable water and waste water valves: Orange.

4. Heating/cooling valves: Blue.

5. Fire suppression valves and drains: Red.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to be painted or directly receive adhesive labels.

B. Install identifying devices after completion of coverings and painting.

3.2 INSTALLATION

A. Do not install identifying devices over factory installed equipment labels.

B. Locate identifying devices in clear view for simple identification.

C. Tag automatic controls, instruments, and relays. Key these to control system schematic drawings.

D. Frame and install approved equipment and valve directories in each mechanical room, at a location designated by the Contracting Agency.

E. Pipe Identification:

1. Identify piping, concealed or exposed, using ANSI A13.1 compliant pipe labels. Identify both service and flow direction in accordance with the following table:

Abbreviation	Legend	Color (Letters/Background)
CW	Domestic Cold Water	White/Green
HW	Domestic Hot Water	White/Green
HWC	Domestic Hot Water Circulation	White/Green
HWS	Heating Water Supply	White/Green
HWR	Heating Water Return	White/Green
GHS	Glycol Heating Supply	White/Green
GHR	Glycol Heating Return	White/Green
RL	Refrigeration - Liquid	Black/Orange
RS	Refrigeration - Suction	Black/Orange
FOS	Fuel Oil Supply	White/Brown
FOR	Fuel Oil Return	White/Brown
ARV	Acid Resistant Vent	Black/Orange
ARW	Acid Resistant Waste	Black/Orange
W	Sanitary Drain	White/Green
V	Sanitary Vent	White/Green

Abbreviation	Legend	Color (Letters/Background)
RL, ORL	Rain Leader, Overflow Rain Leader	White/Green
SD	Storm Drain	White/Green
FW	Fire Suppression Water	White/Red
CA	Compressed Air	White/Blue

2. Pipe label letters shall be a minimum of 1/2-inch high and increase with pipe diameter as follows:

Pipe Outside Diameter	Letter Height
0.75" to 1.25"	0.5"
1.5" to 2"	0.75"
2.5" to 6"	1.25"
8" to 10"	2.5"
over 10"	3.5"

3. Install labels in unobstructed view and aligned with horizontal or vertical axis of piping as appropriate. For piping located above the normal line of vision, place labels below the horizontal centerline of the pipe for clear unobstructed view from below.

4. Install labels not to exceed 20 foot intervals along straight piping runs (including risers and drops), close to valves, adjacent to changes in direction and branches, on each side of pipe penetrations through walls or floors, and at each access panel.

5. Pipe labels are not required on exposed pipes in public spaces unless specifically indicated.

F. Pipe Painting:

1. Paint piping insulation exposed in public areas in accordance with Division 09 - Finishes.

2. Paint bare steel piping exterior to the building gray in accordance with Division 09 - Finishes.

3. Do not paint non-ferrous piping/tubing, fittings or valves such as copper or bronze.

END OF SECTION 200553

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 200556 - INTERIOR TRENCH EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes general requirements, products, and methods of execution relating to excavation, back-fill, and compaction of inside trenches for mechanical work. Inside trenches are those which occur within an arbitrary, imaginary boundary five feet beyond the outside perimeter of the structure.

B. Related Sections:

1. 200000 - Mechanical General Requirements
2. 221100 - Domestic Water Piping and Specialties
3. 221300 - Sanitary Waste and Vent Piping and Specialties
4. 231113 - Fuel Oil Piping and Specialties
5. 232113 - Hydronic Piping and Specialties
6. 233100 - Ducts and Accessories

1.2 SYSTEM DESCRIPTION

A. Provide trench work for mechanical work of every description and of whatever substance encountered to the depth indicated, or to provide pipe slopes and elevations shown on the Drawings. Excavate and backfill utility trenches. Place and compact bedding material. Compact backfill material.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 TRENCH BACKFILL

A. Obtain trench backfill material from trench excavation. If sufficient suitable trench backfill material is not available from trench excavation, import it from sources approved by the Contracting Agency.

B. Use granular material, free from large stones, boulders, debris, and frozen material. Maintain moisture content within a range that will allow specified compaction.

3.2 EXCAVATION

A. Place excavated material suitable for back-fill in an orderly manner, and in conformance with safety codes.

B. Dispose of material not suitable for back filling.

C. Form bell holes so pipelines rest on continuous undisturbed soil. If larger rocks or boulders are encountered, remove them. If trenches are below specified grade, backfill to required depth with select granular materials free from debris, rock, or frozen material, and compact to proper grade before installing piping.

3.3 LOCATION

A. Locate trenches to accommodate utilities shown on the drawings.

B. Excavate trench with adequate width to allow compaction equipment to be used at the sides of pipes.

C. Make trench side slopes conform to prevailing safety code requirements.

3.4 DEWATERING

A. Perform whatever work is necessary to prevent the flow and accumulation of surface or ground water in the excavation.

3.5 TIMING

A. Do not back-fill until underground mechanical system has been properly tested, inspected and approved.

B. Coordinate with the work of others, and complete trench work in a timely manner.

3.6 BEDDING MATERIAL

A. Select bedding material from trench excavation using care to separate it from unsuitable material. If suitable bedding material is not available from trench excavation, import it from sources approved by the Contracting Agency.

B. Use granular material, free from large stones, boulders, debris, and frozen material. Maintain moisture content within a range that will allow specified compaction.

C. Do not use any frost susceptible materials.

3.7 BEDDING

A. Place bedding material under, around, and over the pipe in lifts not exceeding six inch in depth.

B. Work material around pipe by hand methods, taking care to keep any oversize or sharp stones out of contact with the pipe, and to provide uniform support for the pipe.

C. Cover pipe with bedding material to building sub-grade or to a minimum 12-inch depth before adding other backfill.

3.8 BACKFILLING

A. Continue placing backfill material until trench is completely filled to building sub-grade, or as shown on the Drawings.

B. Place backfill material in lifts not to exceed 6-inches in depth.

3.9 COMPACTION

A. Compact bedding material to at least 95 percent of maximum density, taking care not to damage the pipe.

B. Compact backfill under footings, slabs, and other structures to 95 percent of maximum density or more, if required by the Contracting Agency. Where 95 percent compaction cannot be achieved, fill remaining voids with concrete. Provide compaction tests every 100 feet.

C. Compact other areas to preclude future settlement, or at least to 85 percent of maximum density.

3.10 FINISHING

A. After completion of backfilling, dispose of excess material and smooth the surface to grade.

B. Do not allow heavy equipment to be used over backfilled work that does not have sufficient cover to prevent pipe damage.

3.11 SPECIAL PRECAUTIONS

A. Avoid unauthorized and unnecessary excavations.

B. Minimize number and size of excavations under footings or bearing walls.

C. Support footings, foundations, and walls with timbers and jacks if there appears to be any possible chance of damage and keep such precautions in place until work is completed and sufficient backfill is in place to eliminate possible damage.

D. Avoid damage to existing underground services, cables, conduit lines or foundations. Repair any existing underground work damaged at no additional cost to the Owner.

E. Protect excavated materials from moisture during the period prior to reinstallation.

END OF SECTION 200556

SECTION 200700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Specific requirements, products and methods of execution which relate to the insulation of ducts, fittings, equipment, pipes and other surfaces of the mechanical installation.

B. Related Sections:

1. 200000 - Mechanical General Requirements
2. 221100 - Domestic Water Piping and Specialties
3. 221300 - Sanitary Waste and Vent Piping and Specialties
4. 224000 - Plumbing Fixtures and Equipment
5. 232113 - Hydronic Piping and Specialties
6. 233100 - Ducts
7. 238316 - Radiant Floor Heating Equipment

1.2 DESCRIPTION

A. Provide thermal insulation for ventilation system ductwork and building service piping.

B. Provide insulation for exposed ADA plumbing fixture piping.

1.3 REFERENCES

A. International Building Code (IBC).

B. International Mechanical Code (IMC).

C. International Energy Conservation Code (IECC).

D. ASHRAE 90.1 - 2010 Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. NFPA 90A - 2002 Standard for the Installation of Air Conditioning and Ventilating Systems.

F. NFPA 90B - 2006 Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

G. MSS Standard Practice SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.4 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

B. Qualifications: Submit manufacturer and Applicator qualifications, showing compliance with Article 1.5.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years' experience.

B. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years' experience.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturer of each product.

PART 2 - PRODUCTS

2.1 FIRE RATING OF MATERIALS

A. Provide insulation products used aboveground in building with burning characteristics in compliance with NFPA Standards 90A and 90B: Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Tested according to UL 723, ASTM E84, or NFPA 255.

B. Insulation specified for use underground and aboveground away from the building might have other burning characteristics. Use such products only where specifically required.

2.2 FIBERGLASS INSULATION

A. Provide piping insulation products as follows:

1. Thermal conductivity K equals 0.24 at 100 degrees F. mean temperature, ASTM C335.

2. Factory applied vapor-barrier, flame retardant all service jacket and tape, with permeability rating equal to 0.02 perms, ASTM E96.

3. Temperature limits for fiberglass pipe insulation: 350 degrees F, unless otherwise indicated.

4. Manufacturers: Johns Manville, Owens Corning, Knauf Fiber Glass, or approved equal.

B. Provide ductwork insulation products as follows:

1. Flexible insulation: Average thermal conductivity K equals 0.24 at 75 degrees F. mean temperature at 1.5 pcf density, ASTM C335.

2. Rigid insulation: Average thermal conductivity K equals 0.24 at 75 degrees F. mean temperature at 3.0 pounds per cubic feet (pcf) density, ASTM C518.

3. Factory-applied vapor barrier flame-retardant Foil-Scrim-Kraft (FSK) or all-service jacket and tape, with permeability rating equal to 0.02 perms, ASTM E96.

4. Temperature limits for fiberglass duct insulation: 250 degrees F. unless otherwise indicated.

5. Manufacturers: Johns Manville, Owens Corning, Certainteed, Knauf Fiber Glass, or approved equal.

2.3 FLEXIBLE FOAM PLASTIC

A. Thermal Conductivity: 0.27 at 75 degrees F mean temperature, ASTM C518.

B. Water Vapor Transmission: 0.08.

C. Flame-spread rating of 25 or less and a smoke-developed rating of 50 or less as tested by ASTM E 84.

D. Manufacturer: Armaflex, Aerotube, Rubatex.

2.4 FIXTURE INSULATION ASSEMBLY

A. Manufacturer: Proflo PF200 Series, or approved equal.

B. Description: Protective single piece cover manufactured specifically for plumbing fixture supplies and drains.

C. Performance/Design Criteria:

1. Burning characteristics: Self-extinguished zero seconds per ASTM D-635.

2. Bacterial/Fungus Resistance: Zero growth per ASTM G21 and G22.

D. Material: Molded vinyl with 1/8 inch wall, internal and reusable fasteners, and tool-less tear-to-fit trim feature.

2.5 CANVAS JACKETING

A. Insulating Lagging Canvas: Eight ounces per square yard minimum, fire-retardant material complying with fire ratings specified above. Manufacturer: Chas Harmon "Osnaberg", Claremont Company Inc., “Claretex”, or approved equal.

B. Lagging Adhesive: Plastic synthetic resin emulsion adhesive; watertight, mildew resistant, fire retardant. Manufacturer: Childers Chil-Perm CP or approved equal.

2.6 METAL JACKETING

A. 27 gauge (U.S. Standard) heavy corrugated aluminum.

B. Preformed fitting covers.

2.7 COATINGS

A. Coatings: UL labeled.

B. On cold or dual service lines, use vapor barrier type coatings.

2.8 PREFORMED FITTING COVERS

A. One piece premolded PVC jacketing and fitting covers specifically designed for the service intended.

B. Install per manufacturer's instructions and secure with manufacturer's color matching PVC tape.

C. Manufacturer: J-M “Zeston”, TeeCee, Proto, Certainteed.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not apply insulation materials until surfaces to be covered are clean and dry and foreign material such as rust, dirt, etc. is removed. Keep insulation clean and dry during installation and during the application of any finish.

B. Do not install the insulation on pipe fittings and pipe joints until the piping has been tested and approved.

C. Do not install the insulation on ducts or fittings until the ductwork has been tested and approved.

D. Do not apply under conditions of excessive humidity or at temperatures below 50 degrees F. or above 100 degrees F.

E. Provide insulation support blocks, shields, and transitions for hangers, supports, anchors, and guides. Coordinate insulation requirements through rated assemblies and Listing penetration's requirements.

F. Adjust hangers, guides, anchors, and supports after insulation installation has been approved.

3.2 PIPE INSULATION

A. Cold Piping:

1. Includes domestic cold water, plumbing and other vents through roof, chilled water, heat recovery, refrigeration, and other cold piping to zero degrees F.

   a. Insulate plumbing vents from three feet below the under deck of the roof to the termination above the roofline.

2. Insulate with sectional fiberglass and provide a completely sealed vapor barrier. Provide insulation thickness per Insulation Thickness Table.

3. Insulate valves, unions, flanges, fittings, tanks, vessels, air separators, heat exchangers, and similar components, except where indicated otherwise.

B. Hot Piping:

1. Includes domestic hot water supply and recirculation and hydronic heating.

2. Insulate with sectional fiberglass. Provide insulation thickness per Insulation Thickness Table.

3. Insulate valves, unions, flanges, fittings, tanks, vessels, air separators, heat exchangers, and similar components, except where indicated otherwise.

C. Buried Piping. Insulate with flexible foam plastic insulation; glue seams with manufacturers recommended cement.

D. In addition to specified jackets, provide heavy corrugated aluminum jacket on piping insulation anywhere piping is exposed below eight feet zero inches above floor in public areas.

E. Insulation Thickness Table (units are in inches):

Fluid Design Operating Temperature Range	Less than 1	1 to <1-1/2	1-1/2 to <4	4 to <8	8 and up
Heating Systems (Water and Glycol Solutions) and Domestic (Hot Water and Hot Water Circulation):					
141 °F to 200 °F	1.5	1.5	2	2	2
105 °F to 140 °F	1.5	1.5	2	2	2
Cooling Systems (Chilled Water and Glycol Solutions, and Refrigerant):					

Fluid Design Operating Temperature Range	Less than 1	1 to <1-1/2	1-1/2 to <4	4 to <8	8 and up
40 °F to 60 °F	1.5	1.5	1.5	1.5	1.5
Below 40 °F	1.5	1.5	1.5	1.5	1.5
Heat Recovery Systems (Water and Glycol Solutions):					
35 degrees F to 90 degrees F	1	1	1.5	1.5	1.5
Domestic Cold Water:					
All	1	1	1.5	1.5	1.5
Rain leaders, Plumbing vents through roof:					
All	1	1	1.5	1.5	1.5

3.3 TECHNIQUE FOR APPLICATION TO PIPES

A. Close longitudinal joints of pipe insulation firmly and butt insulation sections firmly together. Neatly and smoothly adhere laps and butt strips.

B. Clean the contact area on jacket for adhesive lap strips and butt strips so it is free from fingerprints, oil, construction dust and other contaminants. Clean surfaces with tack rags, methanol, or other suitable agent before attempting to adhere the strip. Apply pressure to adhesive strip with suitable tool immediately after adhering. Remove insulation with inadequately sealed joints and install new sections. Outwardly clinching staples may be used to reinforce joints.

C. Continuously seal vapor barriers. If staples are used at laps, seal the entire length of stapled lap with adhesive jacket tape applied as specified above for laps and butts. Sectionalize vapor barrier by sealing ends of insulation sections at not more than 25 feet intervals, to prevent moisture migrating lengthwise. Apply butt strips over joint as above.

D. Provide double insulation thickness on piping in outside walls and within five feet of vehicle doors or other large openings.

E. Except as indicated, locate pipe hangers and rollers outside insulation. Provide insulation saddles or sheet metal shields around insulation. On pipes two inches and larger, within the area of each insulation shield, use calcium silicate or cellular glass on the lower half of the insulation, equal in thickness to adjacent insulation.

F. Where piping is installed outdoors, provide two-layer glass cloth and four-layer weatherproof vapor barrier adhesive coating, in addition to jacket specified.

3.4 TECHNIQUE FOR APPLICATION TO PIPE FITTINGS, UNIONS, FLANGES,EQUIPMENT, AND VALVES

A. Insulate fittings, valves, and flanges to the same thickness as the pipe insulation.

B. Any of the following methods of insulation are acceptable:

1. Blanket Wrap: Wrap the fitting with compressed glass fiber blanket. Wire the blanket securely in place and cover with a smooth layer of insulating/finishing cement. Cover with glass mesh tape, adhering it with an adhesive coating.

2. Fabricated Segments: Cut mitered segments from pipe insulation that has the same wall thickness as adjacent pipe insulation to form a cover which will fit snugly around the fitting. Wire the segments firmly in place and seal the joints with insulating/finishing cement. Apply adhesive coating and wrap with glass mesh tape, then apply another layer of the same coating over the whole assembly.

3. Cement: Apply insulating or insulating/finishing cement, molding it to the contour of the fitting. When area is large, apply an under layer of cement, wrap this with glass mesh tape, then apply an outer layer of cement. If the insulation is not concealed the exposed surface of insulating/finishing cement shall have a final glass mesh tape wrap embedded in adhesive.

C. In each of the listed methods, to protect the insulation against contact damage, apply an adhesive coating when the cement is completely dry and hard, then wrap with glass mesh tape. Apply another coating of adhesive over the whole assembly.

D. In each of the listed methods, pre-formed fitting covers may be substituted for the tape and adhesive covering specified. Cement and tape fitting covers on cold piping to provide a positive vapor barrier.

E. Removable insulation blankets of comparable insulation value for valves and where equipment require frequent adjustments or maintenance shall be provided; identify and coordinate during submittal process.

F. After insulation has been installed adjust hangers for proper fit, maintain pipe grade and support.

3.5 DUCT THERMAL INSULATION REQUIREMENTS

A. Insulate ductwork as follows:

1. Insulate outside air intake ducts from air intake louver connection to equipment connections (including insulated isolation damper frame) with 2-inch rigid or semi-rigid board insulation.

2. Insulate exhaust and relief ducts from point of discharge to and including two-position motorized damper support frame with 2-inch rigid or semi-rigid board insulation.

3. Supply air ductwork: When mechanical cooling is provided, insulate associated ventilation system supply ductwork from AHU connections to VAV terminal unit inlet connections with 1-1/2 inch thick fiberglass insulation.

4. Return air ductwork: Insulate return air ductwork passing through unheated spaces, within in mechanical rooms and as indicated with 1-1/2 inch fiberglass insulation.

5. Lined ductwork: Provide external duct insulation only when indicated in addition to duct lining.

B. Insulation Type and Finish:

1. Rigid or semi-rigid board where canvas or metal jacket is specified. May also be used in place of blanket insulation where practical.

2. Blanket insulation where rigid board is not specified or indicated. Proper installation is critical. Loose joints and sagging insulation shall require re-insulation of entire branch or main duct before acceptance and during warranty period.

3. Fiberglass or canvas jacket over board insulation in mechanical and boiler rooms less than 10 feet above finish floor, where exposed in finished rooms and where indicated. Seal jacket with vapor barrier lagging adhesive.

4. Ductwork insulation to have a completely sealed vapor barrier, except segmental insulation on medium/high velocity trunk ducts and warm air ducts in concealed spaces, where approved.

3.6 TECHNIQUE FOR APPLICATION TO DUCTWORK

A. Rigid and Semi-rigid Insulation:

1. Impaling Over Pins: Install insulation with edges tightly butted using adhesive and metal pins. Impale insulation on pins welded to the duct and secure with speed clips. Trim off pins close to speed clip. Space pins as required to hold insulation firmly against duct surface but not less than one pin per square foot.

2. Other Method of Securement: If the welded pin method is not feasible, secure the insulation to the duct with adhesive. Cover the entire surface of the metal with adhesive when applying to the underside of horizontal ducts. Application to top and sides may be in strips with a minimum of 50 percent coverage. Additionally, secure insulation with No. 16 galvanized wire on not more than 12 inches on center. Provide metal angle at corners to protect edges of insulation.

3. Vapor Barrier: Seal joints and speed clips with adhesive tape of similar construction to insulation jacket. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique. Glass cloth tape set in adhesive may be used. Provide metal or plastic corner angles within eight feet of floor, walkway, or stairs.

4. Provide fiberglass or canvas jacket where specified. Completely cover with minimum 1/8" lagging adhesive. Cover canvas with two heavy coats of same adhesive and completely fill the weave. Inspect when dry for complete vapor barrier throughout and refinish as required.

B. Blanket Insulation:

1. Position insulation so that longitudinal seam will be underneath and not supporting weight of sheet. Remove a uniform strip of insulation from backing to provide a lap strip. Butt insulation and secure lap strip with outwardly clinching staples.

2. Use pins to secure blanket on large flat areas as specified for rigid insulation. Reinforce jacket at pin penetration where required.

3. Seal laps, staples and butt joints with adhesive tape of similar construction to insulation jack. Seal speed clips if used. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique.

4. When system is under pressure, inspect insulation for inflation caused by improperly sealed ducts. Repair duct seal and reinsulate as necessary.

5. The Contracting Agency may inspect completed insulation and test taped joints for adhesion. Seal laps and butt tapes that can be removed with reasonable force shall require that entire branch or trunk duct be reinsulated.

3.7 FIXTURE INSULATION ASSEMBLY

A. Insulate hot water and cold water supply and waste piping exposed beneath sink and lavatory fixtures designated on drawings or specified in Section 224000 - Plumbing Fixtures, as intended for use by the handicapped.

B. Install in accordance with ANSI A117.1. - 2009.

END OF SECTION 200700

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 211000 - WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes performance requirements, products, and methods of execution relating to fire suppression for the project. The contract documents have required performance, materials, and installation requirements which exceed code minimums. This Section is substantially a “performance” specification.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 213000 - Fire Pumps
4. 283100 - Addressable Fire Alarm

1.2 REFERENCES

A. Provide fire suppression in accordance with the provisions of the following codes and standards:

1. International Fire Code - 2012, IFC.
2. International Mechanical Code - 2012, IMC.
3. International Building Code - 2012, IBC.
4. Uniform Plumbing Code - 2015, UPC.
5. NFPA 13 - 2010, Installation of Sprinkler Systems.
6. NFPA 24 - 2010, Installation of Private Fire Service Mains and Their Appurtenances.
7. NFPA 25 - 2011, Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
8. NFPA 70 - 2014, National Electric Code, NEC.
9. NFPA 72 - 2013, National Fire Alarm and Signaling Code.
10. NFPA 101 - 2012, Life Safety Code.
11. NFPA 291 - 2010, Fire Flow Testing and Marking of Hydrants.

12. ASCE 7 - 10, Minimum Design Loads for Buildings and Other Structures.

13. Foundation for Cross-Connection Control and Hydraulic Research, 9th edition, University of Southern California.

14. Underwriters Laboratories, UL, Fire Protection Equipment Directory.

1.3 SYSTEM DESCRIPTION

A. Provide complete wet and dry pipe automatic fire sprinkler systems with fire and jockey pumps, hydraulically calculated using density/area method to protect the entire facility and fully operational. Comply with the Contract Documents requirements, applicable codes and standards, as well as the Authority Having Jurisdiction (AHJ) requirements. The contract documents have performance, materials, and installation requirements which exceed code minimums.

B. Provide sprinklers utilizing systems compatible with the specific application throughout the building, including outside roof canopies and loading docks, attic areas, crawlspaces, built-in display cabinets, file storage areas, underfloor areas, exterior platform or dock, garage, mechanical and electrical areas, balconies, and all building areas as shown and described in the contract documents. Work includes complete installation of sprinkler heads in finished ceilings.

C. Provide fire suppression system(s), complete and fully operational, in accordance with the contract documents and the applicable codes and standards to protect the areas noted. Work includes installation of heads in finished ceilings.

D. Provide seismic anchoring, bracing, supports, and clearance for equipment, pipes and sprinkler heads per NFPA 13, International Building Code, and ASCE 7; most conservative criteria shall govern.

E. Provide labor, materials, and equipment as required to test sprinkler heads as required per NFPA 25. Test shall be coordinated with Contracting Agency for specific systems and areas.

F. Provide listed sprinkler flex hose for sprinkler heads in suspended ceiling assemblies. Other methods to maintain required clearances are not allowed.

G. Provide provisions including isolation valves and fittings for inspection, testing, and maintenance of water-based fire protection systems identified in NFPA 13 and NFPA 25.

H. Provide a test valve at the hydraulic remote area in both dry and wet systems to equal the required flow of one or more sprinklers head. Wet pipe systems may be reduced to one sprinkler head.

I. Work includes complete installation of pipes and sprinklers in many types of spaces and finished ceilings, architectural features, and building lines. Route pipes above ceilings where possible. Exposed pipes shall follow architectural elements/building lines for visual and symmetric appearance. Design and installation of sprinkler systems shall incorporate aesthetic review comments including routing and concealment of lines, exposed pipe, sprinkler head finish and locations, and exterior penetrations.

J. Sprinkler systems shall follow these general requirements:
   1. All areas and spaces shall be protected by the automatic sprinkler systems.
   2. Garage and related areas shall be dry pipe system with sprinkler pipes concealed in areas with ceiling soffit or other finished areas.
   3. Loading dock and similar exterior areas shall be dry pipe system.

K. NFPA 13-2010 Ch. 5 Classification of Occupancies and Commodities, Ch. 11.2.3 Water Demand Requirements, and Ch. 21 Special Occupancy Requirements shall be the minimum criteria for automatic fire suppression.

L. Provide sprinkler zone by building floors and areas as indicated. Coordinate with and obtain approval from Contracting Agency where alternative layout is beneficial to building configuration and usage.

M. Dry pipe systems shall be required to provide water delivery per NFPA criteria and in 60 seconds or less, regardless of the system size. Design shall incorporate provisions for testing dry pipe system before substantial completion. Locate inspector's test connection arrangement at the most remote branch line at the highest elevation.

N. Provide labor, materials, and equipment as required to facilitate the commissioning process of systems and equipment within this scope of work. Perform tests and verification procedures required for the commissioning process as requested by the Contracting Agency and directed by the Contractor's Commissioning Representative.

1.4 SUBMITTALS

A. Submittals shall be complete for review. Drawings, calculations, and product cutsheets shall be complete and submitted together in one package. See Section 200000 - General Mechanical Requirements for additional requirements not covered below.

B. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Contract Documents.

   1. Submittals will not be checked for quantity, dimension, fit, or for proper technical design of manufactured equipment.

   2. Providing a complete and satisfactory working installation is the responsibility of the Contractor.

   3. Product data, shop drawings, and calculations shall be submitted together for review. Partial submittals will not be reviewed.

C. Electronic Submittals:

   1. Provide electronic submittal in PDF format in addition to hard copy submittal.

   2. Electronic submittals shall follow the organization and formatting required for paper submittals.

   3. Provide electronic bookmarks within the PDF document in place of tabs and sub-tabs.

4. If individual PDF files are provided for each product or shop drawing sheet, organize files into folders and name files and folders to correspond with applicable specification sections or drawing titles.

5. PDF documents to be without security and be searchable, as well as copied and pasted. For scanned documents, run the optical character recognition (OCR) function to ensure the document is searchable and can be copied and pasted.

6. Reduce PDF file size by removing data and file creation elements not needed for final file presentation.

D. Product Data:

1. Submit product data for items specified in Part 2 and those products required by the performance standards of this Section. Identify catalog designation and/or model number and neatly annotate each salient characteristic and design option of the product. Identify operation characteristics, performance curves and rated capacities of products and devices to show compliance with shop drawings and calculations.

2. Provide exterior and interior signage with placement locations indicated on shop drawings.

3. Provide data on fire-stopped penetrations, including product being submitted, the rating of the assembly it will be used for, and the applicable Through Penetration Firestop System drawing(s) from the UL Fire Resistance Directory.

E. Shop Drawings:

1. Submit Authority Having Jurisdiction approved sets of shop drawings and calculations. Drawings and calculations shall include the NICET certification and State of Alaska Permit IIC or IIC-DO number and signature, or signed seal of a licensed professional engineer, and the fire suppression Contractor's Alaska specialty license number.

2. Shop drawings shall be submitted with information in compliance with NFPA 13 and other performance standards of this Section. Shop drawings shall include but not limited to the following:

a. Name of Contracting Agency, Occupant and Building Permit number.
b. Location, including street address and legal description.
c. Point of compass.
d. Fire Department connections.
e. Necessary controlling equipment.
f. Location of water source, type, routing, depth of bury, and size of supply pipes. Identify location and size of city main and whether it is dead-end or circulating loop and distance to the flow data test hydrant.
g. Distribution system pipes and outlets. Include pipe and fitting types.
h. Sprinkler connection, drop, details including supports required for flex pipe.
i. Supports, brackets, restraints, and seismic attachments details and schedules.
j. Reflected ceiling plan showing ceiling heights, construction type, proposed location and type of sprinkler heads, and other ceiling devices such as HVAC diffusers, loud speakers, type and location of light fixtures, etc.

k. Interference control between sprinkler system and other trades.
l. Full height cross section, indicating basic building construction system, sprinkler piping arrangement, and elevation of the highest sprinkler head.
m. Location of partitions. Identification of full height walls and draft stops.
n. Location and size of unprotected concealed spaces.
o. Identification of unheated areas and areas that cannot be reliably maintained above 40 deg. F.
p. Water flow test results, including testing agency, time, date, and location of test.
q. Make, model, type, orifice, finish, color, and temperature rating of sprinklers and their respective locations.
r. Sprinklers with sprinkler guards.
s. Extended coverage sprinklers.
t. Corrosion resistant sprinklers.
u. Ceiling slopes greater than 2 to 12 shall be identified.
v. Clearly identify each hydraulic remote area and associated calculations with hazard type and density.
w. Hydraulic node points.
x. The square footage area protected by each system.
y. Make, model, and size of valves and equipment, including: control valves, pre-action, deluge, alarm valves, check valves, hose valves, and related appurtenances.
z. Identify drum drip drains, main drain, low point drains, drain receptors, and inspector test stations.
aa. Indicate the type and location of pipe hangers, equipment supports, seismic movement, and seismic restraints.
bb. Make, model, size, and locations of pipe couplings, fittings, and flanges.
cc. Make, model, size, power requirement, and location of alarm bells, buzzers, detectors, switches, air compressors, and panels.
dd. Provisions for flushing and backflow device system demand forward flow test and test discharge to safe location.
ee. Name, address, and telephone number of the fire protection specialty Contractor. If design is by a separate firm, include the name address, telephone and fax numbers, and email of the design firm.
ff. Complete legend of abbreviations and symbols indicated.
gg. Complete schedule of room occupancies.
hh. Location of structural penetrations and verification that structural penetrations have been coordinated and approved.
ii. Note the size, location, and extent of “exposed” pipes.
jj. Location of fire rated assemblies.
kk. Total number of sprinklers on each dry-pipe or pre-action system.
ll. Capacity in gallons of each dry-pipe system.
mm. Fire pump assembly with flow meter and test header.
nn. Pump controllers, automatic transfer switches, jockey pump, power supply, fittings, suction and discharge connections, and water supply conditions.

F. Design Data:

1. Submit Authority Having Jurisdiction approved sets of calculations. Drawings and calculations shall include the NICET certification and State of Alaska Permit IIC or IIC-DO number and signature or stamp of a licensed professional engineer and the fire suppression Contractor’s Alaska specialty license number. Submit complete hydraulic

calculations which were used to prepare the final design drawings. One set will be retained by the Engineer.

2. Product data, shop drawings, and calculations shall be submitted together for review; partial submittals not allowed.

3. Systems shall be limited to a maximum of 175 PSIG, unless otherwise approved. Systems requiring pressures 175 PSIG and higher shall have pressure reducing valves, controls, and related equipment incorporated.

4. Submit water flow information used for hydraulic calculations:

   a. Fire hydrant flow tests shall be in accordance with NFPA 291 and the Authority Having Jurisdiction. Submitted for approval to the Authority Having Jurisdiction. Obtain and verify the water supply static pressure and residual pressure at full flow of the test hydrant, at a time of day, during the peak demand on the system, at the point of connection to the water utility system or at a nearby point acceptable to the approval authority. Obtain this data from flow tests or system network design calculations with reliability acceptable to the approval authority. Use this data in flow calculations and include it with the calculation's submittal. Identify the testing agency, date of test, and the source of the test data.
   b. If the Contractor conducts the flow test, a representative of the AHJ and Contracting Agency shall witness the test. Submit a written procedure and certification for the test, which shall be in compliance with NFPA 13 and NFPA 291 for flow testing water supplies and approved by the AHJ. Provide a minimum of hours advance notice of test to the Contracting Agency.
   c. Hydraulic calculations shall be accomplished in compliance with the procedures established in NFPA 13. In addition to minimum NFPA 13 standard, a minimum 10 percent pressure and flow buffers are required to be designed into the system. Where local authorities require additional buffer, comply with the more demanding requirement.
   d. For each zone hydraulic calculations shall be accomplished in compliance with the procedures established in NFPA 13. In addition to NFPA 13 minimum requirements, hydraulic calculations for each zone will demonstrate that the required pressure is a minimum 10 percent lower than supplied pressure at design flow.
   e. Hydraulic calculations accomplished by computer program for submittal shall be accompanied by a complete legend of the abbreviations, nodes, and symbols utilized on the computer printout.
   f. Hydraulic calculations shall follow NFPA 13 requirements and shall clearly identify the following:
      1). Sprinkler type and "K" factor.
      2). Pipe and fittings type, size, and inside diameter.
      3). Fitting equivalent length chart that complies with the "C" factor and pipe type.
      4). NFPA hazard designation, design density, and size of the design remote area.
      5). The elevation of the "highest" sprinkler.
      6). Extended coverage sprinklers shall include design pressure and coverage identified on the drawings and manufacturer's product information to confirm usage. Hydraulic calculations shall identify extended coverage sprinklers and operating pressure.

7). The available water supply and system demand at the point of connection to the water supply, indicated on a logarithmic graph and required safety factors. Include hose demands.

g. Equipment, pipe, fittings, and sprinklers used in calculations shall match installed system. Variances shall require redesign and installation by contractor.

G. Quality Assurance/Control Submittals:

1. Design Data: Provide hydrant flow test reports or other information used for design.

2. Certificates Initial Submittal:

a. Submit Contractor's qualifications, proof of three years' experience under this Contractor's firm name, and references for at least five projects in Alaska of similar type, size, or complexity.
b. Submit a copy of designer's NICET certification and resume', Alaska Permit number and level or Alaska P.E. license number.
c. Submit a copy of backflow assembly tester qualifications and certificate.
d. Submit a copy of Contractor's State of Alaska Fire Protection Permit and Administrator's License for the appropriate type of systems provided.

3. Certificates Post Construction:

a. Submit a letter of certification for backflow assembly installation and testing, signed by the installer/tester.
b. Provide copy completed of the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Above Ground Piping.
c. Provide test report for hydrostatic test of piping, to include a test of piping between the fire department connection and the check valve.
d. Provide test report confirming proper operation of tamper, supervisory, and flow, switches and system alarms.
e. Provide test report for trip test of dry pipe system.
f. Submit test results to Factory Mutual Global for acceptance.
g. Provide a letter of certification stating that testing and flushing has been performed in accordance with the applicable codes and standards. Itemize codes and standards complied with.

4. Provide Manufacturer's Installation Instructions, and Manufacturer's field reports.

5. Fire suppression system shall be installed, tested, as-builts completed and installation approved by the Authority Having Jurisdiction, AHJ, before substantial completion request or notification is made.

6. Structural tests and special inspections required by IBC or ASCE-07 shall be identified on the shop drawings, products submitted and coordinated during installation. Reports shall be submitted. Secure required services and pay for tests and inspections.

7. Significant changes in piping due to on site coordination with other trades and existing conditions shall require hydraulic recalculation to confirm adequate pipe sizing and be resubmitted to AHJ and Contracting Agency's Insurance agency.

H. Review, Approvals, and Permits Required

1. Obtain written review and/or approval of the entire fire suppression system design and arrangement from the following authorities:

a. Contracting Agency - (Approval).
b. Authority Having Jurisdiction, AHJ - (Approval).
c. Architect - (Review).
d. Mechanical Engineer - (Review).
e. Contracting Agency's Insurance Agency - (Review).
f. Insurance Services Office (ISO) - (Review).

2. Comply with the above review comments, revising the system design as required, and resubmitting in a timely manner, so as not to hinder the construction schedule.

3. Obtain and pay for required permits, inspections, tests, and approvals as required by Authority Having Jurisdiction.

I. Operation and Maintenance Manual Submittal:

1. Include manufacturers' descriptive literature, operating instructions, installation instructions, testing certificates, maintenance and repair data, parts listings, and spare parts list.

2. Electronic copy of the Authority Having Jurisdiction approved hydraulic calculations, drawings, and their review letter.

3. Table showing NFPA 25 maintenance requirements.

4. Provide an electronic copy of operations and maintenance manual in PDF format with bookmarks matching table of contents, including as-built shop drawings with each required paper copy.

J. Closeout Submittals:

1. Refer to Division 1 for general procedures for submittals.

2. Project Record Documents: Record actual locations of components and locations of access doors required for access or valving.

3. Warranty: Submit manufacturer warranty and ensure forms have been completed in Contracting Agency's name and registered with the manufacturer.

4. Submit a written affidavit at the completion of the system, stating that the fire suppression system as installed complies with referenced Codes and Standards, Authority Having Jurisdiction requirements, and the Contracting Agency's Insurance recommendations.

5. Provide written warranty as specified in Division 1. Furnish written guarantee to the Contracting Agency, that materials installations are free from mechanical defects and guaranteeing to replace and repair any and all unsatisfactory and defective work and items, to the satisfaction of the Contracting Agency, in a timely manner for a period of one year after final acceptance of the Contracting Agency, and to be responsible for any damage caused to the premises for any such unsatisfactory work.

6. Issue a minimum one set of full size as-built drawings and maintenance data to the Contracting Agency's designated maintenance personnel, in addition to required submittals.

7. Train the Contracting Agency's designated maintenance personnel in the operation and maintenance of the fire suppression system. Minimum eight hours of training is required. Provide training in accordance with other requirements specified elsewhere in Division 1

K. Maintenance Information and Framed Building Plan:

1. Coordinate with Section 283100 - Addressable Fire Alarm for fire alarm graphical displays and maps.

2. Provide information for a complete 1/16-inch scale building floor plan showing system control valves, drain stations, alarm and control panels, test valves, fire pumps and controllers, water storage tank(s) and other primary fire suppression devices. Indicate sprinkler zones, boundaries, and types of systems. Each zone shall be assigned a unique sequential identifier number. Submit this plan prior to substantial completion for review by the Contracting Agency.

3. Orient the floor plan in a manner that is consistent with the building. Rotate graphic layout as required to show North, South, East, and West, as it applies to the building.

4. Enclose the plan in a professionally fabricated metal picture frame with 1/8 inch rigid clear plastic cover. Minimum 1 inch frame width. Locate the framed plan in the fire suppression control valve room on the wall with the spare sprinkler cabinet.

5. Include step by step instructions to place the fire suppression system in service as well as to take it out of service. Provide complete maintenance information of primary fire suppression equipment, valves, fittings, sprinklers. Identify equipment indicating whether devices are replacement items or repairable. Provide parts list and suppliers for repairable items.

6. Provide three copies of the latest edition of NFPA 25.

7. Include step by step procedures for required operational weekly/monthly/annual service and testing as required by NFPA 25. Provide a complete report of field test operations and results prior to substantial completion.

L. Record Drawings:

1. Maintain current and up-to-date As-Built prints of the fire suppression system at the job site.

2. Approved full size As-Built drawings and electronic copy of as-built drawing files in PDF and DWG formats shall be submitted with IO&M manuals.

1.5 QUALITY ASSURANCE

A. Furnish the services of a qualified and approved fire suppression subcontractor to provide the work of this specification section. Unless otherwise noted, this is substantially a "performance" specification.

B. Minimum qualifications of the Contractor/subcontractor shall include the following:

1. Specialist Firm: Company specializing in automatic fire suppression/sprinkler systems, possessing a minimum of three years of experience with systems similar in nature to the type specified herein. Demonstrate satisfactory completion of five projects of similar size and scope in the State of Alaska; provide references.

2. Backflow Prevention: Installation and testing by a certified backflow assembly tester, in accordance with the Uniform Plumbing Code and Foundation for Cross-Connection Control and Hydraulic Research. Provide a copy of the certification and test results.

3. Design Certification: Drawings and calculations shall be prepared by a Level III or IV Fire Sprinkler Designer, certified by the National Institute for Certification in Engineering Technologies (NICET), in Fire Protection Engineering Technology Automatic Fire Sprinkler System Layout who also have their State of Alaska Permit IIC or IIC-DO license, or an Alaskan Licensed Professional Engineer.

4. Maintain a complete stock of replacement parts.

5. Remain on 24 hour call for emergency service.

6. Maintain an office and telephone, with authorized representatives of the fire suppression contractor's firm, including the Designated Project Administrator, with a physical presence and address in Alaska.

7. Bids by wholesalers, contractors, or any firm whose principal business is not that of manufacturing and/or installing fire suppression systems are not acceptable.

C. Material:

1. Equipment and components: Bear the "UL" label or the "FM" approval marking.

2. Equipment and components: Bear the "FM" approval marking or "UL" if FM is not available and approved by Contracting Agency.

3. Grooved joint couplings, fittings, valves, and specialties shall be from the same manufacturer, including grooving tools.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to the site under provisions of Division 1.

B. Deliver and store valves in manufacturer's packaging with labeling in place.

C. Prior to installation, pipes shall be wrapped with protective wrapping.

1.7 PROJECT/SITE CONDITIONS

A. Temporary occupancy permits, or partial occupancy require alarm and life safety systems to be fully operational. Expedite installation and complete life safety requirements for temporary and phased occupancy.

B. Check dimensions indicated on the Architectural and Structural Drawings and verify dimensions at the site before fabricating any portion of the system. Any discrepancies in piping and head locations resulting from failure to do so shall be corrected expeditiously to provide proper coordination of trades.

C. Coordinate work with that of other trades to make sure that adequate space is provided, including requirements for accessibility and serviceability. Locate sprinkler heads a minimum 6 inches distance from ceiling T-Bar, structural elements, devices, and other installed equipment. Adjust final location of piping and heads in field to accomplish these requirements for coordination.

D. Identify structural penetrations for pipes and submit details of those penetrations to the Structural Engineer for approval. Replace structural members that are damaged, cut, or penetrated without approval at no additional expense to the Contracting Agency.

E. Design automatic fire suppression piping in this facility with full consideration given to the building occupants, minimizing inherent health risks caused by self-inflicted injury from the fire suppression system and/or damage to the system. This includes but is not limited to exposed pipes, security of system controls and service points, and sprinkler types specified for this application.

1.8 ANNUAL MAINTENANCE AGREEMENT PROPOSAL

A. Provide upon request a cost proposal for performing annual maintenance recommended by NFPA 25.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide only products that are a standard product of a manufacturer regularly engaged in the manufacture of fire suppression equipment.

B. Products and materials shall have a minimum working pressure of 175 PSIG and capable of withstanding a hydrostatic test pressure of 200 PSIG at 2 hours test pressure without damage, unless noted otherwise for higher pressure ratings or basis of design includes higher pressure ratings.

1. Exception for approved ancillary devices that are normally isolated from the fire water and sprinkler lines shall have a minimum rated 150 PSIG working pressure.

C. Submittals are required for all equipment, materials, and products.

D. Glycol systems for fire suppression shall not be used.

E. Exterior items shall be chrome finish or stainless steel.

2.2 LABELS, TAGS, AND APPROVALS FOR PRODUCTS

A. Products UL or FM listed, labeled, and specifically approved for the fire suppression application where they are used.

B. Products FM listed, labeled, and specifically approved for the fire suppression application where they are used.

C. Label pipes, riser assemblies, pre-action systems, and alarm valves, including zone designation; enamel on metal for valves.

D. Tag equipment for maintenance and operations. Include in shop drawings and O&M manual.

2.3 MANUFACTURERS

A. Sprinkler System and Components:

1. AGF.
2. Central.
3. Croker.
4. Gem Sprinkler.
5. Grinnell.
6. Kennedy.
7. Metraflex.
8. Milwaukee.
9. Notifier Company.
10. Potter-Roemer.
11. Potter Electric.
12. Reliable.

13. Star.

14. System-Sensor.

15. Tyco.

16. Tolco.

17. Victaulic.

18. Viking.

2.4 PIPE

A. Plastic pipe is not allowed.

B. The use of pipe nipples less than 1-inch in diameter and less than schedule 40 wall thickness is not allowed.

C. Pipe shall be identified including manufacturer's name, model designation or schedule.

D. Below Ground Pipe and Fittings:

1. Ductile iron pressure pipe, Class 52, 150 PSIG working pressure, cement-mortar lining.

2. Ductile iron cement-mortar line mechanical restraint joint fittings.

3. External zinc coating, anode bags, and bonding cables. Coordinate with civil requirements.

4. Thrust restraint joints and concrete thrust blocks for horizontal and vertical bends.

E. Wet Pipe Sprinkler Systems:

1. Metallic pipes shall be listed for the intended service by UL or FM.

2. Whenever pipes other than steel schedule 40 is utilized, submit a statement that the pipe complies with NFPA 13 standards, the pipe strength is adequate for the application, and the pipe corrosion resistance ratio (CRR) shall be equal or greater than 1.0, equivalent to schedule 40 pipe for the installed system. Include this CRR data in product submittal.

F. Dry Pipe Sprinkler Systems:

1. Schedule 40 hot dipped galvanized steel pipe in accordance with NFPA 13. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

2. Welded pipe joints and fittings shall not be used on galvanized pipe.

2.5 FLEXIBLE SPRINKLER HOSE WITH THREADED END FITTINGS

A. Flexible 1-inch 304 stainless steel flexible sprinkler hose products shall be FM Global or UL tested and approved and submitted for the specific application. The drop system shall include required mounting brackets and appurtenances.

B. Equivalent length of 1-inch schedule 40 steel pipe and pressure drop information shall be included in product submittal and hydraulic calculations.

2.6 FITTINGS, ABOVE GROUND

A. Grooved Fittings, Couplings, and Mechanical Tees:

1. Grooved Fittings: ductile iron fittings with flow equal to standard pattern. Fabricated or segmented fittings are not acceptable. Couplings and mechanical tees shall be standard painted, unless indicated otherwise.

2. Grooved joint couplings shall consist of two ductile iron housing segments with pressure responsive gaskets and zinc plated, hot dipped galvanized or stainless steel hardware as required for application:

   a. Rigid type: Couplings shall provide joint rigidity, support and hanging in accordance with NFPA 13.
   b. Flexible type: For use in locations where vibration attenuation and stress relief or flexible connectors are required.

B. Threaded fittings shall be compatible with piping system and include cast iron Class 125 and 250, and malleable iron Class 150 and 300 steel.

C. Pipe Flanges shall be compatible with piping system and include: Cast iron Class 125 and 250, and malleable iron Class 150 and 300 steel.

D. Welded Pipe Fittings for Wet Pipe Sprinkler Only: Limited to Weld-o-lets, Thread-o-lets, Gruv-o-lets, Tees, and Welded Flanges. Welding limited to shop fabrication work with approved quality control process, welding procedures, and welders for specific application.

E. Welded pipe joints and fittings shall not be used on galvanized pipe or on pipes with wall thickness less than schedule 10.

F. Clamp-on, saddle type, or mechanical tee are not allowed for new work.

G. Other means of joining pipe are not permitted.

2.7 VALVES AND ALARM ASSEMBLIES

A. Valves: UL or FM listed and labeled and specifically approved for the fire suppression application where they are used. Minimum working pressure 175 PSI non-shock cold water. Higher pressure rating as required.

1. Control Valves: Fire suppression system control valves shall be supervised with switches compatible with the fire alarm system or other methods in compliance with NFPA 13.

a. OS&Y Gate Valves: Rated working pressure 250 PSI non-shock cold water.
b. Butterfly Valves: Rated working pressure 300 PSI non-shock cold water with pressure responsive seat, 360-degree circumferential seating. Weatherproof handwheel actuator housing and two integrated supervisory switches. Grooved, threaded, or wafer type acceptable.
c. NRS Gate Valves: Rated working pressure 250 PSI non-shock cold water.

2. Swing Check Valves, Spring-Assisted: Rated working pressure 250 PSI non-shock grooved end, flanged, or wafer type, listed for vertical or horizontal installation.

B. Test and Drain Valves:

1. Test orifices shall be clearly identified and selected for smallest sprinkler orifice on system riser.

2. Drain valve position clearly identified and valve accessible.

3. Sight glass for visual confirmation of water flow.

4. Valve assembly shall be bronze body.

C. Fire Department Valve:

1. Fire department valve shall be 2-1/2 inch angle valve, cast brass body, polished chrome finish, and red hand wheel.

2. Valve cap with chain. Cap and chain finish to match valve body.

3. Threads shall match fire department standards.

4. Provide a low point drain at connection to prevent freezing.

D. Provide sprinkler alarm valve assemblies, appropriate to the system, complete with trimmings and accessories for proper alarm initiation and interface with fire alarm system. Alarm valve internal components shall be replaceable without removing the valve from the installed position. Include water flow detector, inlet and discharge pressure gauges, main drain, and inspectors test connection.

E. Dry Pipe Sprinkler Systems:

1. Dry Pipe Valve:

a. Dry Pipe Valve, complete with required trimmings, including inlet and outlet pressure gauges and main drain that safely discharges outside.
b. Valve shall be externally resettable and internal components shall be replaceable without removing the valve from the installed position.
c. Pressure Switch, to signal system discharge.
d. Low Air Alarm Switch, to signal low air pressure in the dry-pipe fire-protection system.
e. Accelerator, Quick Opening Device: As required with trim and compatible with the dry pipe valve.

F. Provide electrical alarm and control wiring in accordance with NFPA 72 and Division 26 requirements.

G. Provide identification sign (enamel on metal) for valves per NFPA requirements.

H. Valves in galvanized piping systems shall be bronze.

2.8 SPRINKLER HEADS

A. Provide sprinklers as required by NFPA 13 standards and in compliance with the IBC Chapter 9. Sprinkler heads using O-ring water seals are not allowed. Sprinklers shall be glass bulb type, with hex-shaped wrench boss integrally cast into the sprinkler body. Sprinkler finish and style as follows:

1. In areas with surface mounted light fixtures attached to finished suspended ceilings, provide standard spray pendant sprinklers, and escutcheons to position the sprinkler deflector below the light fixture. Sprinklers and escutcheons to be chrome finish.

2. In areas with recessed lighting flush to the suspended ceiling finish, provide recessed standard spray pendant sprinklers. Sprinklers and escutcheons to be chrome finish.

3. In areas with recessed lighting flush to the suspended ceiling finish provide concealed type pendant sprinklers with cover plates. Color of cover plate to be approved by the architect and owner.

4. Sprinklers above ceilings and exposed ceiling areas shall be bronze finish, standard spray, upright or pendant type.

5. Sidewall sprinklers shall be bronze finish in service areas, and chrome throughout public areas.

6. Dry pendant and dry sidewall sprinklers protecting inside freezers, coolers, and similar areas below 40 degrees F. shall be chrome finish with insulating boot for vapor tight and thermally insulated assembly. Sprinklers shall be non-recessed and with guards.

7. Dry pendant and dry sidewall sprinklers protecting entry vestibules and other public areas susceptible to temperatures below 40 degrees F. shall be chrome finish recessed.

8. Dry pendant and dry sidewall sprinklers protecting unheated areas and piped from wet pipe systems shall have an “A Length” dimension of not less than 18 inches.

9. Sprinklers with orifices less than K-4.2 shall be noted during submittal for specific application for approval and have an independent strainer with access for maintenance.

10. Guards are required on exposed piping sprinklers where subject to mechanical damage and sprinklers less than eight feet zero inches above finish floor. Provide the same brand sprinkler guard or escutcheon with the same finish as the sprinkler on which it is to be installed. Red guards are acceptable for bronze sprinklers only. Chrome finish guards are required for chrome sprinkler heads. Physically wire guards closed.

11. Sprinklers of correct temperature rating shall be installed according to NFPA 13.

12. Provide a minimum of 2 spare sprinkler heads of each type and temperature rating, minimum of 6 total, and a minimum of one sprinkler wrench for each type of installed sprinkler. Wrenches shall directly engage the wrench boss cast into the sprinkler. Provide plugs where dry type sprinklers are used. Spare sprinkler cabinet shall be red sheet steel manufactured by the sprinkler manufacturer. Mount cabinet on the wall within 60 inches of the main sprinkler control riser.

13. Provide additional sprinklers, as requested by Authority Having Jurisdiction, at no additional cost to the Contracting Agency.

B. Sprinkler heads on dry pipe systems shall be listed for the application and shall be upright or pendent, installed on a return bend.

2.9 FIRE DEPARTMENT CONNECTION, FDC

A. Cast brass body and trim having individual double female snoots with rigid end three inches NPT by 2-1/2 inch pin lug hose thread swivels; plugs and chains; angle body outlet size as required; horizontal flush mounting with sillcock and flange plate; exposed parts chrome finish.

B. Provide number of snoots as required by NFPA 13.

C. Connection to be complete with 1/2-inch automatic ball drip valve piped to exterior.

D. Provide appropriate minimum 1-inch raised lettering on mounted metal signage to properly identify connection.

E. Provide hose threads to match the threads of the local fire department.

F. Provide knox stainless steel lockable caps, as approved by the Authority Having Jurisdiction.

2.10 BACKFLOW DEVICE

A. Provide full line size double check valve reduced pressure principal backflow assembly and devices in accordance with the Uniform Plumbing Code requirements before FDC or sprinkler riser connections.

B. Provide access to backflow device and gauges for conducting backflow device full flow test with provisions to record inlet and discharge pressures and discharge flow discharge to safe location.

C. Backflow assemblies including approved orientations shall have successfully passed the laboratory and field evaluation tests conducted by the University of Southern California Foundation for Cross-Connection Control.

2.11 MAIN DRAIN

A. Provide main drain exterior downspout nozzle fitting with chrome finish.

2.12 PIPE AND EQUIPMENT ANCHORS, BRACING, HANGERS, AND SUPPORTS

A. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping and sprinkler heads per NFPA 13, International Building Code, and ASCE 7. Most conservative criteria shall govern.

B. Provide flexible couplings, bracing, and other components required and compatible with the piping materials and fittings.

C. Hangers, bracing, and seismic details and locations shall be included on the shop drawings.

2.13 INSPECTORS TEST CONNECTIONS

A. Provide inspectors test connections for complete system testing, as indicated, and as required by Authority Having Jurisdiction.

B. Chrome plate pipe and fittings exposed outside building. Provide chrome plated set screw escutcheon.

C. Polished brass plate pipe and fittings exposed outside building. Provide brass plated set screw escutcheon.

2.14 ELECTRICAL WORK

A. Provide electrical components, equipment, wire, conduit, connections, devices, and services as required by NFPA 72 and Division 26 requirements.

2.15 VALVE SUPERVISION, TAMPER, SWITCHES

A. Provide supervision of valves on water supplies, sectional control and isolation valves, floor control valves, water supplies to standpipes, and other valves in supply pipes to sprinklers.

B. Provide valve supervision switches compatible with fire alarm system in NEMA 4 enclosure.

C. Coordinate with Division 26 requirements.

D. Provided by Division 26. Refer to Section 283100 - Addressable Fire Alarm.

2.16 WATER FLOW DETECTORS

A. Provided by Divisions 26, 27 and 28. Refer to Section 283100 - Addressable Fire Alarm.

B. Provide vane-type water flow detectors installed at each system or zone control and for the main system header for multiple zone systems.

C. Provide test connection at each flow detector.

D. Provide water flow detectors compatible with fire alarm system in NEMA 4 enclosure.

E. Coordinate with Division 26 requirements.

2.17 PRESSURE GAUGES

A. Pressure gauges shall be 3-1/2 inch corrosion resistant moving parts, polycarbonate window with connection not smaller than 1/4 inch NPT, and maximum limit not less than twice the normal system working pressure at the point where installed.

B. Provide 3-way globe shutoff valve with provisions for removal and draining on each pressure gauge.

2.18 AIR SYSTEM MAINTENANCE AND APPURTENANCES

A. Provide dedicated single unit electric motor driven air compressor of size, configuration, and capacity as required by NFPA 13. Provide vibration isolation mounts for air compressor equipment.

B. Provide compressor controls, including starter and power disconnect. Coordinate electrical power requirements with Divisions 26, 27 and 28. Provide 115V, 1Ph motor suitable for connection to 15 amp circuit.

C. Provide piping, fitting, valves, pressure relief valve, and controls necessary to connect to systems. Minimum 1/2 inch pipe to dry pipe valves and shall enter the system above the priming water level of the dry pipe valve.

D. Provide automatic air maintenance system available at all times and capable of restoring system normal air pressure within 30 minutes and compatible with dry pipe systems.

E. Coordinate connection of alarm contacts with Section 283100 - Addressable Fire Alarm.

F. Coordinate location and installation to minimize noise and disruption during operation and maintenance.

G. Shop drawings and product submittals shall identify system components, sound valves, alarms, cycle times, pressures, recommended clearances, and appurtenances.

2.19 DRY SYSTEM LOW PRESSURE ALARM

A. Provide UL approved low air pressure alarm switches on each dry system, compatible with fire alarm system.

PART 3 - EXECUTION

3.1 COORDINATION

A. The fire suppression contractor shall coordinate their work with the work of other trades to assure timely installation and efficient use of mechanical areas including, but not limited to, boiler rooms, fan rooms, and ceiling spaces.

B. Promptly remove any work installed without proper coordination and reinstall in a manor to allow for a good practical arrangement of items which need to be installed by other trades involved.

C. Costs associated with coordination, arranging or rearranging of the fire suppression system shall be borne by the affected contractor, without causing any additional expense or delay to the Contracting Agency.

D. Installation, testing, O&M manuals, record drawings, and AHJ approvals shall be completed, submitted, and approved by the Contracting Agency before beneficial occupancy.

E. Coordinate with architectural requirements for prepping and painting of pipes, hangers, brackets, restraints, and appurtenances in public exposed areas.

3.2 PIPING INSTALLATION

A. Install pipes, fittings, and appurtenances in accordance with codes and recommended practices. Follow manufacturers' installation instructions.

B. Installed system to have a corrosion resistance ratio (CRR) equal to or greater than 1.0.

C. Pipes and equipment not directly serving exit enclosures or exit passageways shall not be routed through them. Only pipes and equipment directly serving exit enclosures or exit passageways shall be allowed in these spaces. There shall be no penetrations whether protected or not between adjacent exit enclosures or exit passageways.

D. Sprinkler pipe and fittings shall be installed to flush and drain system. Drains shall be accessible. Discharge test pipes, backflow system demand flow tests, and system main drain to safe location outside. Coordinate discharge point with Contracting Agency.

1. Arrange pipes to drain to the main drain valve where practicable. Where connection to the main drain or other exterior drainage is impractical, as shown on shop drawings, install low point drain stations in accordance with NFPA 13.

2. Identify the location of drain and test stations with signs on access panels, ceiling panels, or walls adjacent to the station, visible from the floor.

3. Riser main drains shall have hose bibb connections for maintenance drainage where drainage to exterior safe location is not allowed or impractical.

4. Coordinate routing of drain lines to waste receptors. Direct connection shall not be made between sprinkler drain lines and sewers.

E. Seismic protection for the piping system shall be in accordance with NFPA 13 standards, FMG, and ASCE 7. Include seismic restraint details with installation shop drawings.

F. Provide clearance around pipes extending through walls, floors, ceilings, platforms, and foundations, including drains, fire department connections, and other auxiliary pipes. Holes shall be sized 2 inches larger than the pipe for pipe 1 inch to 3-1/2 inches and 4 inches larger for pipe 4 inches and larger, unless flexible couplings are located within 1 foot of each side of item penetrated, and excluding frangible construction that is not required to have a fire resistance rating.

G. Install pipes to conserve building space and route pipes around roof hatches, electrical panels, access panels, and maintenance accesses.

H. Minimum 2 inches clearance from structure not used to support pipes.

I. Provide service access around equipment per manufacturer’s requirements, minimum of 18 inches.

J. Provide flexible couplings as required per NFPA 13 and at the following locations:

1. Drops to hose lines, rack sprinklers, and mezzanines regardless of pipe sizes.

2. Penetrated fire and smoke rated assemblies.

3. Within 24 inches of building's expansion joints.

4. Within 12 inches above and within 24 inches below for the floor in multistory buildings.

K. Sprinkler pipes shall be substantially supported from the building structure, which shall support the water loaded pipe plus a minimum 250 pounds temporary point load applied at the point of hanging. Pipe hangers shall include 250 pounds and weight of 5 times the pipe filled with water.

L. Dry system pipes shall be installed to allow full service and complete drainage of the entire system. Dry pipes shall be sloped to accomplish this requirement. Discharge dry pipe drains to the outside. Drum drips shall be provided on exterior pipes and interior areas subject to moisture accumulation.

M. Pipes shall be concealed, except at ceilings exposed to structure, or as noted. Conceal pipes in areas with finished ceilings except where otherwise specified or indicated. Coordinate with the other trades to take timely advantage of available space above ceilings, below raised floor, in pipe and duct spaces and elsewhere.

N. Pipes shall not be concealed in walls.

O. Piping to sprinklers below ceilings with minimum 1 inch outlets.

P. Pipes in exposed ceiling areas shall be limited to branches serving heads in the area. Pipe routing shall be coordinated to minimize visual impact and approved prior to installation.

Q. Provide penetrations where pipes pass through walls, floors, or ceilings. Penetrations shall be in accordance with UL Fire Resistance Directory for “Through Penetration Firestop Systems (XHEZ)”.

R. Pipes supported from manufactured structural members shall comply with truss manufacturer’s installation recommendations for hanger attachments and loading of pipe hangers.

S. Pipe hangers attached to bar joist with wood top and bottom chords shall pre-drill chords for fasteners. The minimum distance for fasteners from truss “panel points” shall be 6 inches or farther per manufacturer’s recommendations.

T. Pipes passing pre-drilled structural elements to be shown on approved shop drawings.

U. Fasten trapeze members to truss chords or structural members.

V. Install “beam clamp” type fasteners with retainer straps and locking nuts. Retainer strap shall be tight to beam.

W. Pipe hangers: “rod and ring” type hangers throughout for dry pipe system. Minimum 1/2 inch of adjustment on each side of the hanger ring nut, to allow for piping grade adjustment in the future.

X. Pipe size reductions by one-piece reducing fittings; bushing shall not be used.

Y. Provide test connection for each flow switch and supervisory switch on each shutoff valve.

Z. Install a test valve at the remote area in dry and wet pipe systems to equal the required flow of one sprinkler head.

AA. As a minimum, install pressure gauges at system entrance, forward flow test main drain, floor control valve main drains, and where indicated.

BB. Welded pipe shall be shop fabricated by certified welders and procedures.

CC. Coat exposed threads with corrosion inhibitive paint per manufacturer's instructions; "cold galvanization" for galvanized pipe and fittings.

DD. Underground ductile iron pipe and fittings with external zinc coating, anode bags, and bonding cables. Coordinate with civil requirements.

3.3 GROOVED AND ROLLED FITTINGS

A. Follow the manufacturer's suggested methods to prepare gaskets, pipes, and fittings to prevent leakage, system breakdown, and designed pipe and fitting movement.

B. Cut grooved pipe shall be limited to schedule 40 pipe.

C. Welding fittings shall not be used on galvanized pipe.

D. Installers to have been trained by the coupling manufacturer in the use of grooving tools and installation of product. The manufacturer’s representative shall periodically visit the job site to ensure best practices are being followed.

E. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices are being followed.

3.4 BONDING

A. Provide underground ductile iron pipes with metallic bonding to produce electrical conductivity.

B. Bond wire shall be type RHW-USE-2 for underground wet use, minimum size 1/0 neoprene-jacketed copper conductor shaped to stand clear of pipe joint.

C. Coordinate with civil requirements for installation and continuity of fire water service lines.

3.5 SPRINKLER HEAD INSTALLATION

A. Sprinkler heads to be centered per approved shop drawings. Changes due to field conditions shall be pre-approved.

B. Sprinkler heads to be centered on acoustical lay-in panels and symmetrically 4-way on architectural drawings laid out in each separate room or space with GWB type ceiling regardless of finishes and minimum Code requirements.

C. Sprinkler heads shall be connected to system via minimum 1-inch diameter flexible stainless steel sprinkler hose in suspended ceiling areas, areas subject to tenant renovations, where indicated, and where required for seismic criteria. Ceiling systems with listed flex hose connections shall be identified on shop drawings.

D. Escutcheons and cover plates shall be metallic and listed for the assembly.

E. Provide guards where sprinklers may be subject to mechanical damage and in accordance with contract documents.

F. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb.

G. The sprinkler bulb protector shall be removable by hand, without tools or devices that may damage the bulb.

H. Sprinkler head temperature ratings shall be selected based upon installed distance from heat source.

I. Provide clearance for removal of sprinkler heads and minimum 1 inch clearance from structure. Exclude concealed, recessed, and flush types, which have clearances above the ceiling.

J. Identify sprinklers with less than 8 feet between them and include listing and NFPA 13 criteria.

3.6 DRY SPRINKLER HEADS

A. Provide dry sprinkler heads in areas potentially subject to freezing including, but not limited to ceilings of entry vestibules, overhangs requiring fire suppression, rooms with combustion air openings, walk-in freezers and refrigerators, and under over-head garage type doors and other areas where temperatures may drop below 40 degrees F.

1. Provide insulating boot for vapor tight and thermally insulated assembly. Coordinate with architectural requirements.

2. Coordinate “A Length” dimension with each assembly penetrated when piped from wet pipe system. Include information in submittals.

B. Review work of Divisions 26, 27 and 28 and determine which areas are not heated during times of primary power failure.

3.7 SPRINKLER PIPES AT ELECTRICAL, TELECOM/DATA, AND COMPUTER ROOMS

A. Provide complete interface with electrical/transformer rooms in compliance with the National Electrical Code and AHJ.

B. Route no pipes through rooms except branch piping supplying sprinklers protecting the room. Branch pipes shall not exit electrical room to supply additional sprinklers outside the room.

C. No pipes shall be routed above electrical panels or telecommunication racks.

D. Noncombustible hoods or shields, as described in NFPA 13, shall be provided to deflect direct sprinkler discharge away from electrical panels and equipment.

E. Maintain a minimum of 42 inches clear in front of electrical panels, coordinate with electrical requirements.

3.8 ELEVATOR SHAFTS, PITS, AND EQUIPMENT ROOMS

A. Sprinklers in the elevator shaft and equipment room are not required, except a sprinkler is required within two feet of the bottom of the pit, for systems utilizing polyurethane-coated steel belts or similar combustible belt materials, or as required by the Authority Having Jurisdiction.

B. Provide sprinklers at the top and bottom of elevators that utilize polyurethane-coated steel belts or similar combustible belt material. Sprinklers shall also be required if the hoisting means penetrates into the machine room/space that is separate from the hoistway.

1. Provide pre-action valve and appurtenances for sprinklers and locate in accessible space outside of hoistway and machine rooms.

2. Coordinate with electrical for shunt trips and shut down of elevators prior to or on activation of these sprinklers.

C. Elevator pits shall have draining requirements as required by the Authority Having Jurisdiction. Verify pit drainage. During construction drawing review or site review for existing facilities, pits without drainage or inadequate drainage system shall be identified and the Contracting Agency shall be immediately notified in writing.

3.9 FIRE DEPARTMENT CONNECTIONS, FDC

A. Location of the fire department connections shall be as indicated on drawings and as approved by the AHJ.

B. Working space of not less than 36 inches in width, 36 inches in depth, and 78 inches in height shall be provided and maintained in front of and to the sides of wall-mounted FDCs.

C. Fire department connection shall be located 42 inches above grade, unless otherwise required by the AHJ.

D. FDC line check valve shall be located in heated area of building, minimum of 24 inches from exterior or cold wall penetration and line slope to drain to automatic drip valve.

E. Piping between check valve and outside hose couplings shall have automatic drip valve.

F. Provide vehicle impact protection where the FDC is subject to impact by a motor vehicle.

3.10 PRESSURE GAUGES

A. Pressure gauges shall be installed at fire water service entries, fire pump discharge pipe, pressure tanks, each main drain connection, top of each standpipe, and above and below each: alarm check valve, dry pipe valve, deluge valve, backflow preventer, or system riser check valve.

B. Gauges shall be installed to permit removal and gauge connections shall be equipped with a shut-off valve and provisions for draining.

C. Gauges shall be located so that water cannot freeze.

3.11 IDENTIFICATION

A. Valves: Control, auxiliary control, drain, and test connection valve shall have permanently secured weatherproof metal identification signs.

1. Systems with more than one control valve that must be closed to work on an area shall have a sign referring to existence and location of other valves.

2. Control valve identification to include its function and what it controls.

B. Coordinate with valve, zones, and pipe identification with Framed Building Plan and fire alarm nomenclature.

C. Rooms containing control valve, fire pump, and similar equipment requiring fire department identification or access shall have signage.

D. Exterior and interior signage shall be coordinated with architect and AHJ requirements.

E. Sprinkler system hydraulic design and relevant general information. Information shall meet NFPA 13 and NFPA 25 requirements for inspection, testing, and maintenance.

3.12 ELECTRICAL WORK

A. Provide electrical work, connections, routings, signals, power, and services as required by NFPA 72 and Division 26 requirements.

B. Coordinate switches, connections, alarms, and number and type of devices with electrical work. Devices shall be compatible with Division 26 requirements.

3.13 PAINTING

A. In areas exposed to public viewing, exposed sprinkler system and elements shall be painted, excluding sprinkler head assemblies.

B. Clean and prepare pipe, fittings, hangers, restraints, supports, and miscellaneous items for areas to be painted.

C. Refer to the requirements specified in Division 09.

3.14 ACCESS DOORS

A. Provide access doors where “Fire Suppression” valves, switches, drain valves, or other controlling or monitoring devices are concealed. Label doors for quick location and recognition of concealed devices. For rated assemblies provide rated access door to match assembly's rating.

3.15 INSPECTORS TEST PIPING

A. Discharge inspectors test pipes to approved floor drains in non-public areas, or outside building, but not on main walkways or over architectural surfaces easily stained or difficult to clean. Do not terminate discharge more than 48" above grade. Discharge main test and drain pipes used for service line flow testing outside and terminate with a 2-1/2 inch hose connection.

B. Dry pipe and double interlock inspector’s test connection arrangement to be located at the most remote branch line at the highest elevation.

3.16 FLUSHING

A. Systems shall be arranged for flushing. Cross main ends shall be provided with readily removable fittings and shall terminate with 1-1/4 inches or larger pipe.

B. Flush underground service pipes and distribution pipes before connecting underground pipes to sprinkler system. Flushing velocity shall be the larger of 10 feet per second flushing velocity or maximum design flow.

C. Flush pipes before pressure testing.

3.17 FIELD QUALITY CONTROL

A. Document each installation and operational step utilizing the approved PC/FT checklists in accordance with Section 019100 - Commissioning.

B. Arrange for proper witnessing of tests, as required by Authority Having Jurisdiction and as specified elsewhere. Contracting Agency's representative may witness tests. Notify Contracting Agency a minimum of 3 days in advance of test.

C. Hydrostatically test piping between the exterior fire department connection and the check valve in the fire department inlet pipe in the same manner as the balance of the system.

D. Spot check each hydraulically remote area installed sprinkler's identification to match approved shop drawings.

E. Conduct tests in accordance with applicable codes. Test above ground and underground pipes at minimum 200 PSIG hydrostatic for two hours.

F. Trip test dry pipe system to confirm system discharge time and submit test report. Dry pipe systems shall produce water at inspector test per NFPA 13 criteria and less than 60 seconds regardless of system volume. Provide a quick-opening device, accelerator, if required to meet discharge time requirements, independent of system volume.

G. Test tamper, supervisory, flow, and system alarm actuations and alarm monitoring systems.

H. Test backflow device in accordance with Uniform Plumbing Code requirements.

I. Provide backflow device full flow test per NFPA 25. Record and submit inlet and discharge pressures and discharge flow.

J. Pipe shall not be concealed until satisfactorily pressure tested.

K. Log of test shall be kept at the job site and shall identify:

1. Who performed the test,

2. Time and date of test,

3. Section of system tested,

4. Results of test,

5. Completed Contractor's Material and Test Certification forms.

L. Verify permanently marked weatherproof metal “Hydraulic Design Information Sign” is secured with corrosion resistant fastener at each alarm valve and information matches approved shop drawings and hydraulic calculations.

M. Provide a letter of certification stating that testing and flushing has been performed in accordance with the applicable codes and standards. Itemize codes and standards complied with.

3.18 TRAINING AND DEMONSTRATION

A. Provide annual operational test including flow performance in accordance with NFPA 13 and NFPA 25 with Contracting Agency's representative and Owner's maintenance personnel.

B. Train the Owner's designated maintenance manager in the operation and maintenance of the entire fire suppression system, minimum of 4 hours on-site training.

C. Training materials shall include approved O&M manual and as-built drawings.

D. Provide documentation stating date and length of training with list of attendees, instructor, and sign-off by Contracting Agency's representative stating that training and demonstration has been completed.

END OF SECTION 211000

SECTION 213000 - FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

2. Automatic Fire Pumps and appurtenances.

3. System Design, Materials, Installation, and Certification.

B. Related Sections:

1. 019100 - Commissioning

2. 200000 - Mechanical General Requirements

3. 211000 - Water Based Fire Suppression Systems

4. 283100 - Addressable Fire Alarm

1.2 REFERENCES

A. Provide fire suppression in accordance with the minimum provisions of the following codes and standards:

1. International Fire Code - 2012, IFC.

2. International Building Code - 2012, IBC.

3. Uniform Plumbing Code – 2015, UPC.

4. NFPA 13 - 2019, Installation of Sprinkler Systems.

5. NFPA 14 - 2019, Installation of Standpipe and Hose Systems.

6. NFPA 20 - 2019, Installation of Stationary Pumps for Fire Protection.

7. NFPA 24 - 2019, Installation of Private Fire Service Mains and Their Appurtenances.

8. NFPA 25 - 2017, Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

9. NFPA 70 - 2014, National Electric Code, NEC.

10. NFPA 72 - 2019, National Fire Alarm and Signaling Code.

11. NFPA 101 - 2012, Life Safety Code.

12. NFPA 291 - 2019, Fire Flow Testing and Marking of Hydrants.

13. ASCE 7 - 10, Minimum Design Loads for Buildings and Other Structures.

14. Foundation for Cross-Connection Control and Hydraulic Research, 9th edition, University of Southern California.

15. Underwriters Laboratories, UL, Fire Protection Equipment Directory.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Provide a fully designed and complete automatic electric motor driven fire pump system.

2. Include fire pump, pressure maintenance (jockey) pump; pump controllers, pump test connection, transfer switches, and associated piping and appurtenances.

B. Performance Requirements:

1. Obtain system approval as required by the Authority Having Jurisdiction.

2. Demonstration proper system operation to Authority Having Jurisdiction and Contracting Agency.

1.4 SUBMITTALS

A. Submittals shall be complete for review. Drawings, calculations, and product cutsheets shall be complete and submitted together in one package. Provide an electronic copy of each submittal in PDF format with bookmarks matching table of contents, including shop drawings with each required hard copy.

B. Submit under provisions of Division I and Section 200000 - Mechanical General Requirements.

C. Submit product data.

D. Shop Drawings:

1. Submit Fire Marshal approved sets of shop drawings and calculations. Drawings and calculations shall include the NICET certification and State of Alaska Permit IIC or IIC-DO number and signature, or signed seal of a licensed professional engineer, and the fire suppression Contractor’s Alaska specialty license number.

2. Shop drawings shall be submitted with information in compliance with NFPA 20 and other performance standards of this Section. Shop drawings shall include but not limited to the following:

    a. Name of the Owner, occupant and Building Permit Number.
    b. Location, including street address and legal description.
    c. Point of compass.
    d. Fire Department Connections.
    e. All necessary controlling equipment.
    f. Location of water source, type, routing, and size of supply piping.
    g. Location, make, model, size, and power requirements of electrical equipment including but not limited to jockey pump, jockey pump controller, alarm panels, bells, buzzers, detectors, and/or lights as well as the useful capacity, in gallons, for the fire water storage tank.
    h. Interference control between sprinkler system and other trades.
    i. Full height cross section.
    j. Make, model, size, and location of all fire suppression valves, pumps and related equipment.
    k. Identify low point drain and test stations.
    l. Indicate the type and location of all piping hangers and equipment supports, with details.
    m. Make, model, size, and locations of all pipe couplings, fittings and flanges.
    n. Name, address and telephone number of the Contractor. If design is by a separate firm, include the name address and telephone number of the design facility.
    o. Complete legend of all abbreviations and symbols indicated.
    p. Location of all unit heaters.
    q. Location of all structural penetrations.
    r. Fire Pump test assembly.
    s. Fire pump:
        1). Name and address of the manufacturer and vendor for the fire pump.
        2). Provide product data including literature on manufacturer's general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls complete with customized wiring diagrams indicating controller specialties matching these contract/bid documents.
        3). Provide manufacturer's installation instruction, including details, connection requirements, and start up instructions for the fire pump.
        4). Provide certification from vendor that all related fire pump equipment including but not limited to jockey pump and fire pump controllers are purchased as a complete package in compliance with NFPA 20.

E. Provide Manufacturer's certification that fire pump meets or exceeds the specified requirements at specified operating conditions. Submit summary and results of shop tests performed in accordance with NFPA 20. Submit a copy of Contractor's State of Alaska Division of Fire Prevention Fire System Permit.

F. Submit a copy of designer's NICET certification and resume', or Alaska P.E. license number and designated project mechanical administrator license.

G. Submit adequate number of State Fire Marshal approved sets of shop drawings, and hydraulic calculations to the Owner for their review. These sets must include the NICET certification or stamp of a licensed professional engineer as described above.

H. Submit all State Fire Marshal written reviews and Contractor responses to reviews to the Owner.

1.5 MAINTENANCE INFORMATION, FRAMED BUILDING PLAN & AS-BUILT DRAWINGS

A. Submit under provisions of Division I.

B. Provide a complete floor plan identifying all system control valves, drain stations, alarm and control panels, test valves, and other primary fire suppression devices. Submit this plan prior to substantial completion for review by the mechanical engineer.

1. Enclose the plan in an architectural metal picture frame with 1/8 inch rigid clear plastic cover. Minimum one inch frame width.

2. Locate the framed plan in Mechanical 153 on the wall with the spare sprinkler cabinet.

C. Include step by step instructions to place the fire suppression system in service as well as to take it out of service. Provide complete maintenance information of all primary fire suppression equipment, including pumps, valves, fittings, and sprinklers. Identify equipment and indicate whether devices are replacement items or repairable. Provide parts list and suppliers for repairable items.

D. Include step by step procedures for required operational weekly/monthly/annual service and fire pump tests, and checklists for trouble shooting pumps, drivers, and controllers. Provide a complete report of field test operation prior to final completion.

E. Provide complete, detailed “As-Built” Record Drawings of the completed system, including detailed control schematics.

1.6 QUALITY ASSURANCE

A. Unless otherwise noted, this is substantially a "performance" specification.

B. Minimum qualifications of the Contractor/Subcontractor shall include the following:

1. Specialist Firm: Company specializing in automatic fire suppression/sprinkler systems, possessing a minimum of three years’ experience with systems similar in nature to the type specified herein.

2. Design Certification: Shop drawings shall be prepared by a person with a minimum certification of level III designer, certified by the National Institute For Certification In Engineering Technologies (NICET), in Fire Protection Engineering Technology Automatic Fire Sprinkler System Layout or registered professional engineer.

3. Equipment and components: Bear the UL label or the FM approval marking.

4. Remain on 24 hour call for emergency service.

5. Bids of wholesalers, Contractor or any firm whose principal business is not that of manufacturing and/or installing and servicing fire suppression systems are not acceptable.

C. System testing:

1. Hydrostatically test the entire system in accordance with NFPA 20 chapter 11-1 standards.

2. Test all system alarm sequences, actuations and alarms.

3. Perform operational tests in accordance with NFPA 20 chapter 11-2 standard.

4. Demonstrate operation of completed system, including load shed to Owner and Authority Having Jurisdiction.

D. Project close-out:

1. Submit a written affidavit at the completion of the system, stating that the fire suppression system as installed complies with all referenced codes and standards, State Fire Marshal's Office, and the Owner's Insurance Underwriters.

2. In addition to required submittals, issue one set (minimum) of As-Built drawings and maintenance data to the Owner's designated facility site maintenance manager.

1.7 REVIEWS, APPROVALS, AND PERMITS

A. Obtain written review and/or approval of the entire fire suppression system design and arrangement from the following authorities:

1. Owner (Review).

2. Owner (Approval).

3. State of Alaska Fire Marshal (Approval).

4. Architect (Review).

5. Mechanical Engineer (Review).

B. Comply with all review comments, revising the system design as required, and resubmitting in a timely manner, so as not to hinder the construction schedule.

1.8 COORDINATION REQUIRED

A. Examine the structural, architectural, mechanical, electrical and other drawings relating to the building and plan the work accordingly. Check and verify dimensions at the site before fabricating any portion of the system.

B. Coordinate work with that of other trades to ensure that adequate space is provided for all work, including requirements for serviceability and accessibility.

C. Identify structural penetrations for piping and submit details to the structural engineer for approval, in a timely manner. Replace structural members that are damaged, cut or penetrated without approval at no additional expense to the Owner.

1.9 MATERIALS HANDLING AND STORAGE

A. Deliver, store, protect, and handle products to the site under provisions of Division 1.

B. Deliver and store valves in manufacturer packaging with labeling in place.

C. Protect pipe with protective wrapping prior to installation on site.

D. Maintain system cleanliness throughout the construction, and deliver the finished installation (pumps, valves, piping, materials, and equipment) in new and clean condition.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide only new materials and equipment, which are standard products of a manufacturer regularly engaged in the manufacture of fire suppression equipment.

2.2 FIRE PUMP

A. Provide all automatic fire pump equipment including, but not limited to the primary fire pump, jockey pump, fire pump controller with automatic transfer switch, jockey pump controller, and test apparatus as a unit package in compliance with NFPA 20 standards. Equipment shall bear the UL label for fire protection application.

B. Vertical in-line fire pump:

1. Provide fire pump as scheduled and configured as shown.

2. Pump and appurtenances must be designed for use in potable water systems.

3. Manufacturer: A-C Fire Pump Systems with Eaton controller (Basis of Design), Patterson, or approved equal.

C. Jockey pump:

1. Provide jockey pump as scheduled and configured as shown.

2. Manufacturer: A-C Fire Pump Systems with Eaton controller (Basis of Design), Grundfos, or approved equal.

2.3 OFF SITE MONITORING OF FIRE PUMP

A. The fire pump shall be monitored off-site at a constantly attended location in accordance with NFPA 20 requirements for the following conditions:

1. Fire pump has operated into a pump motor running condition. This alarm circuit shall be energized by a separate reliable, supervised power source, reduced to not more than 125V.

2. Loss of line power in any phase on the line side of the fire pump motor starter. All phases shall be monitored. Such monitoring shall detect phase loss whether the motor is running or at rest.

3. Phase reversal on the line side of the fire pump motor starter. This alarm circuit shall be energized by a separate reliable, supervised power source, reduced to not more than 125V.

4. Where two sources of power are supplied to the fire pump, this alarm circuit shall indicate whenever the alternate source is the source supplying power to the controller. This alarm circuit shall be energized by a separate reliable, supervised power source, reduced to not more than 125V.

5. Monitoring shall be provided by the central service provider designated by the Owner. Provide required equipment, connections, wiring, conduit, dialers, communicators, etc., to monitor the above items as separate, distinct alarm conditions.

6. Coordinate monitoring requirements with Section 283100 - Addressable Fire Alarm.

2.4 FIRE PUMP SEQUENCE OF OPERATION

A. Building on normal utility power - Actuation of fire pump.

1. Fire pump shall immediately start (reduced voltage start).

B. Fire pump operating on normal (utility) power source - Failure of normal power.

1. Fire pump will stop on loss of power.

2. Initiate an adjustable timer to delay fire pump restart.

3. Load shed building standby load via ATS-S (inhibit ATS-S from transferring from normal to generator power).

4. Start fire pump (reduced voltage start). Delay period shall be adjustable, initially set to 30 seconds.

C. Emergency generator operating, ATS-E and ATS-S in emergency position (building on generator power) - Actuation of fire pump.

1. Initiate an adjustable timer to delay fire pump start.

2. Load shed building standby load via ATS-S.

3. Start fire pump (reduced voltage start). Delay period shall be adjustable, initially set to 30 seconds.

D. Fire pump operating on emergency power - Restoration of normal (utility power):

1. Restore normal power to fire pump after a time delay of 14 minutes.

E. If the emergency source (generator) fails the fire pump transfer switch shall immediately transfer the fire pump to the normal (utility) power source.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. The fire suppression contractor shall coordinate his work with the work of all other trades to assure timely installation and efficient use of the pump room area.

B. Any work installed without proper coordination shall be promptly removed and reinstalled in a manor to allow for a good practical arrangement of all items which need to be installed by all crafts involved.

C. In case of coordination dispute, the Owner shall be consulted and his decision shall be binding.

D. Costs associated with coordination and arranging or rearranging of the fire suppression system shall be borne by the affected Contractor, without causing any additional expense to the Owner.

3.2 SYSTEM TEST

A. Hydrostatically test the entire system in accordance with NFPA 20 chapter 11-1 standards.

B. Test all system alarm sequences, actuations and alarms.

C. Perform operational tests in accordance with NFPA 20, chapter 11-2 standard.

D. Provide 48 hour advanced notice for fire pump tests to allow Owner adequate lead-time to arrange for personnel to witness testing.

3.3 PROJECT CLOSE-OUT

A. Submit a written affidavit at the completion of the system, stating that the fire suppression system as installed complies with all referenced codes and standards, State Fire Marshal's Office, and the Owner's Insurance Underwriters.

B. Issue one set (minimum) of As-Built drawings and maintenance data to the Owner's designated facility site maintenance manager.

C. Train the Owner's designated maintenance manager in the operation and maintenance of the entire fire suppression system.

END OF SECTION 213000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 221100 - DOMESTIC WATER PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, fittings, and connections for domestic potable and non-potable water systems.
2. Mechanical coupling systems.
3. Piping accessories.
4. Valves.
5. Indirect fired water heater.
6. Hot water circulating pumps.
7. Domestic hot water thermal expansion tank.
8. Water hammer arresters.
9. Trap primer valves.
10. Water meters.
11. Cross connection protection devices.
12. Access doors.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200529 - Mechanical Hangers and Supports
5. 200548 - Mechanical Vibration and Seismic Control
6. 200553 - Mechanical Identification
7. 200556 - Interior Trench Excavation and Backfill
8. 200700 - Mechanical Insulation

9. 211000 - Water Based Fire Suppression Systems
10. 221300 - Sanitary Waste and Vent Piping and Specialties
11. 224000 - Plumbing Fixtures
12. 230593 - Testing, Adjusting and Balancing
13. 253000 - Building Automation System Field Devices
14. 255000 - Building Automation Systems
15. 259000 - Sequence of Operation

1.2 REFERENCES

1. International Building Code (IBC).
2. Uniform Plumbing Code (UPC).
3. ASCE 07-05, Minimum Design Loads for Buildings and Other Structures.
4. ANSI A117.1, Accessible and Usable Buildings and Facilities.
5. Foundation for Cross-Connection Control and Hydraulic Research, 9th edition, University of Southern California.
6. NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances.
7. 2011 Reduction of Lead in Drinking Water Act.
8. NSF/ANSI 61 - Drinking Water System Components - Health Effects.

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.
2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.
3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. This section describes specific requirements, products and methods of execution for interrelated systems necessary for the various plumbing systems and equipment.

2. Wetted surfaces of pipes, fittings, valves, and equipment in potable water systems shall be lead free as defined by the 2011 Reduction of Lead in Drinking Water Act.

B. Performance Requirements:

1. Potable water systems shall perform quietly, with no objectionable vibration transmitted to the surrounding construction.

2. Replace piping and equipment that does not perform as intended with properly operating equipment.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate and sequence installation of plumbing systems and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any plumbing components

1.5 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed:

B. Product Data:

1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.

2. Indicate valve data and ratings.

3. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.

C. Shop Drawings:

1. This Section shop drawings to be submitted under Section 200000 - Mechanical General Requirements.

2. Show placement of fixtures and plumbing equipment.

D. Certificates: Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation of cross contamination protection devices.

E. Manufacturer’s Installation, Operation, and Maintenance (IO&M) Manuals.

F. Test and Evaluation Reports:

1. Submit hydrostatic pressure test report.

2. Submit sterilization of system report.

1.6 CLOSEOUT SUBMITTALS:

A. Refer to Section 200000 - Mechanical General Requirements for general closeout submittal requirements for the items listed below, supplemented with the additional requirements listed:

B. Warranty Documentation.

C. Record Documentation:

1. Record actual locations of valves, backflow preventers, water hammer arresters, and other components.

2. Record locations of access doors required for access or valves.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general maintenance material submittal requirements for the following:

B. Tools: Provide an extra set of tools required for the installation of a copper press system.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Company specializing in manufacturing the Products specified in this section with minimum three years' documented experience.

2. Installers: Minimum three years' experience in the installation and start-up of plumbing systems and equipment.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Handling Requirements:

1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.10 WARRANTY

A. Refer to Section 200000 - Mechanical General Requirements for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 WATER SERVICE PIPING (BURIED WITHIN 5 FEET OF BUILDING)

A. Copper (Hard drawn):

1. Tubing: ASTM B42.

2. Fittings:

a. Cast copper alloy (ASME B16.18).
b. Wrought copper and bronze (ASME B16.22).

3. Joints: Solder, Grade 95TA (ASTM B32).

B. Copper (Annealed):

1. Tubing: ASTM B42.

2. Fittings: Cast bronze (ASME B16.260).

3. Joints: Flared.

C. Water service transition into building:

1. Pipe: 4 inch and larger minimum Class 50 cement lined ductile iron pipe (AWWA C151).

2. Fittings: Ductile iron, standard thickness for pipe Class.

3. Joints:

a. Mechanically restrained joints (AWWA C110 and C1530).
b. Manufacturer: EBAA Iron, Inc., Model: Megalug.

2.2 WATER SERVICE PIPING (ABOVE GRADE INSIDE BUILDING)

A. Copper (Hard drawn):

1. Tubing: Type L (ASTM B88).

2. Fittings:

a. Cast copper alloy (ASME B16.18).
b. Wrought copper and bronze (ASME B16.22).

3. Joints: Solder, Grade 95TA (ASTM B32).

B. Copper Press Fitting System:

1. Limited to tubing sizes 4 inch and smaller.

2. Cast or wrought copper fittings, ASME B16.18 or ASME B16.22. Pre-formed grooves with pre-lubricated EPDM O-rings designed to seal fitting to copper tubing water tight with the use of manufacturer's crimping tool. Fittings shall be rated for 250 Degrees F., and 200 psi.

3. IAPMO UPC listing.

4. Manufacturer: Viega ProPress, NIBCO Press System, no substitutions.

2.3 UNIONS (STANDARD)

A. Steel Piping (Threaded):

1. Class 150 malleable iron, ground joint, copper or copper alloy seat. AnvilStar Figure 463. (150 psig steam, 300 wog).

2. Where indicated: Class 250 malleable iron ground joint, copper or copper alloy seat. AnvilStar Figure 554.

B. Copper Piping (Sweat and Threaded): Cast bronze, ground joint, copper to copper, or copper to threaded joint. Nibco 733-LF series.

2.4 DIELECTRIC ISOLATORS (ELECTRICALLY INSULATING)

A. Provide dielectric unions for 2 inch pipe and smaller.

B. Provide dielectric flanges for 2-1/2 inch pipe and larger.

C. Insulating gaskets, all types, shall be suitable for fluid type, temperature and pressure.

D. Galvanized pipe to copper: Brass threaded end and sweat copper end.

E. Black steel to copper: Zinc plated steel threaded end and sweat copper end.

F. Manufacturers: Capitol, Epco, Control Plastics, Watts, or approved equal.

2.5 VALVES

A. General:

1. Select valves of the best quality and type suited for the specific service and piping system used. Minimum working pressure rating 125 psig saturated steam or 200 psig W.O.G. Packing material or seals shall not contain asbestos.

B. Ball Valves:

1. Two (2) inch and smaller: Two piece type, full port, bronze body and silicone bronze ball or chrome plated brass ball, TFE seats, blowout proof stem, 150 psig pressure/temperature rating (steam).

2. Two and one half (2-1/2) inches through four (4) inch: Two piece type, full port, bronze body and silicone bronze ball or chrome plated brass ball, TFE seats, 150 psig pressure/temperature rating (steam).

C. Gate Valves:

1. Two (2) inch and smaller: Bronze body and trim, rising stem, solid wedge. Use only where shown on drawings.

2. Two and one half (2-1/2) inch through four (4) inch: Iron-body, bronze trim, flanged threaded or sweat fitting. Non-rising stem: Inside screw. Rising stem: OS&Y. Bronze valves optional for 2-1/2 inch and three-inch.

D. Globe Valves:

1. Two (2) inch and smaller: Bronze body, renewable disc suitable for service.

2. Two and one half (2-1/2) inch and larger: Iron body, bronze trim, flanged, bronze disc. Bronze valves optional for 2-1/2 inch and three-inch.

E. Swing Check Valves:

1. Two (2) inch and smaller: Bronze body, horizontal swing, Y-pattern, Buna-N-disc for water, oil and gas.

2. Two and one half (2-1/2) inch and larger: Iron body, horizontal swing, bolted bonnet, renewable bronze seat and disc, flanged.

a. Bronze valves optional for 2-1/2 inch and three (3) inch.

F. Butterfly Valves:

1. Six (6) inch and larger: Lug type ductile iron body, EPT O-ring and seat, disc for 150 psig shutoff, valve rated for 220 degrees F. on heating systems and other 200 degrees F. systems. Manufacturers: Dezurik, Homestead, Nibco, Demco, Keystone, Milwaukee, Norris.

G. Drain Valves:

1. Full port ball valve with threaded hose adapter with bronze end cap.

2. Do not use sillcocks or butterfly valves as drain valves.

2.6 BALANCING VALVES

A. Provide a balancing valve at each point shown on the domestic hot water recirculation branches. Except as indicated, balancing valves shall be full line size. Wide open pressure drop selected at one psi (2.3 feet) (nominal).

B. Provide calibrated plug or ball valve type balancing valves with self-sealing quick connect pressure taps, scale and locking device. Include schedule with submittal.

C. Manufacturer: Bell & Gossett, or equal.

D. Provide test kit with gauge and hoses to match balancing valves.

2.7 INDIRECT-FIRED WATER HEATER

A. Provide an indirect-fired water heater of the size and capacity shown on the Drawings. Certify that the heater complies with the requirements of ASHRAE 90.1.

B. Tank:

1. 316L stainless steel shell.

2. Maximum working pressure of 150 psi.

3. Inlet and outlet connections.

4. 3/4-inch tapping for relief valve.

5. Thermal heat trap to reduce standby heat loss.

6. Accessories: ASME rated temperature and pressure relief valve.

C. Polyethylene outer jacket, over CFC-free urethane foam insulation. Insulation thickness and efficiency shall be as required to meet energy efficiency requirements of ASHRAE 90.1.

D. Heat Exchanger:

1. Finned copper with Stanoguard plating.

2. Inlet and outlet heating pipe connections.

E. Controls. Provide a complete and operating control system, including the following features:

1. Electro-mechanical AquaStat temperature control.

2. High temperature limiting device.

3. UL approved controls, factory wired.

4. Provide control wiring diagram.

F. Manufacturer: Amtrol Premier WHS Series or approved equal.

2.8 DOMESTIC HOT WATER CIRCULATING PUMP

A. Direct drive, field replaceable stainless steel cartridge, self-lubricating.

B. Aluminum stator, stainless steel impeller, stainless steel shaft, carbon bearings.

C. O-ring and Gaskets: EPDM.

D. Flange mount, stainless steel construction.

E. Electronically commutated permanent magnet motor (ECM technology).

F. Performance as scheduled.

G. Manufacturers:

1. B&G (Basis of Design).
2. Taco.
3. Approved equal.

2.9 DOMESTIC HOT WATER THERMAL EXPANSION TANKS

A. Tank:

1. ASME stamped.
2. Steel tank shell steel support stand.
3. Enamel or urethane coating.
4. NSF approved polypropylene liner.
5. FDA approved butyl rubber diaphragm.
6. Stainless steel threaded system connection.

B. Operating Characteristics:

1. Maximum Working Temperature: 200 degrees F.
2. Maximum Working Pressure: 175 PSIG.
3. Tank Precharge: 55 PSIG.

C. Manufacturer: Amtrol Therm-X-Trol (Basis of Design), Taco, or equal.

2.10 WATER HAMMER ARRESTERS

A. Manufacturers:

1. Sioux Chief.
2. Precision Plumbing Products.
3. Mifab.
4. Zurn.
5. Any other manufacturer meeting the requirements of the contract documents. Substitution request not required.

B. Pressurized Piston Type:

1. Description: ASSE 1010 certified water hammer arrester.
2. Performance:
   a. Maximum working temperature of 250 degrees F.
   b. Maximum working pressure of 350 PSIG.
3. Materials:
   a. Seamless copper body.
   b. EPDM o-rings lubricated with FDA approved compound.

2.11 TRAP PRIMER VALVES

A. Manufacturers:

1. Precision Plumbing Products.
2. Mifab.
3. ProFlo.

B. Electronic Type:

1. Description: UL listed valve designed to deliver a metered amount of water to floor drain on a timed schedule. Valve includes circuit breaker, test switch, timer, and solenoid valve.
2. Performance: Minimum 2 ounces of water at 20 PSI per drain served.
3. Accessories: NEMA 1, 16 gauge box with removeable cover.

C. Non-Electronic Type:

1. Description: Valve designed to deliver a metered amount of water to floor drain traps upon pressure drop of 10 psi in the cold water line.

2. Performance: Factory set for proper operation with water pressure of 20 to 80 PSI.

3. Materials:

   a. Lead-free brass body.
   b. EPDM o-rings.
   c. Stainless steel mesh screen.

D. Accessories: Distribution unit to serve multiple floor drains from a single trap primer.

2.12 PRESSURE GAUGESProvide where shown on drawings, specified in Part 3, or as required.

B. Bourdon tube type with 4-1/2-inch dial (minimum) accuracy plus or minus one-percent span, recalibratable. Normal operating pressure near midpoint of range. Industrial quality.

C. Gauge cock on gauges and pulsation damper (snubber).

D. Manufacturers: Winters, Trerice, Marsh, Weksler, or approved equal.

2.13 THERMOMETERS

A. Provide where shown on drawings, specified in Part 3, or as required.

B. Liquid in glass type: Industrial quality blue-reading with nine-inch scale length (minimum). Straight angle or adjustable as necessary for visibility.

C. Dial Type: Industrial quality three-inch dial with a 270 degrees (minimum) scale. Straight, angle or remote as necessary for visibility.

D. Normal operating temperature at scale midpoint and sufficient range to cover operating conditions.

E. Provide separable wells of suitable material for piping. Set probe in heat transfer paste recommended by thermometer manufacturer.

F. Manufacturers: Winters, Trerice, Marsh, Weksler, or approved equal.

2.14 BUILDING SERVICE WATER METER

A. Provide rough in for water meter provided by utility company. Coordinate with utility company for space, flow and pressure loss requirements, and install meter. Provide temporary spool piece if meter delivery is delayed.

B. Provide flow monitoring water meter for BAS connection as shown on drawings. Full flow, turbine type with magnetically driven register and contact type pulse transmitter.

C. Manufacturer: Badger, Hersey, Kent, Neptune.

2.15 REDUCED PRESSURE PRINCIPLE BACKFLOW DEVICE

A. The reduced pressure backflow preventer shall consist of two independently operating, spring loaded check valves with a hydraulically operated differential pressure relief valve located between and below the checks, required test cocks, and inlet and outlet resilient seat shut off valves.

B. Modes of Operation:

1. When normal flow exists, both check valves are open and the pressure in the area between the checks, called the zone, is at least two PSI lower than the inlet pressure. The differential pressure relief valve is closed during normal flow.

2. If cessation of normal flow occurs, the differential pressure relief valve will automatically open and discharge to maintain the zone at least two PSI lower than the inlet pressure. This action will prevent a backflow or back siphonage condition. After the required differential is established, the differential pressure relief valve again closes.

C. The assembly shall be constructed using lead free cast copper silicon materials. No special tools shall be required for servicing.

D. Provide installation that meets access requirements of local code amendments.

E. Water pressure drop through the assembly including shutoff valves shall not exceed 14 PSIG at 15 GPM.

F. Manufacturer: Watts Regulator LF909QT-S, or equal.

2.16 DOUBLE CHECK VALVE ASSEMBLY BACKFLOW DEVICE

A. The double check valve assembly backflow-preventer shall consist of two independently operating, spring loaded cam-check valves, required test cocks, and inlet and outlet resilient seat shut off valves.

B. The cam-checks include a stainless steel spring and cam-arm, rubber faced disc, and a replaceable seat. The body shall be manufactured from 300 series stainless steel, lead free, with a single two-bolt grooved style access cover. No special tools shall be required for servicing.

C. Provide installation that meets access requirements of local code amendments.

D. Water pressure drop through the assembly including shutoff valves shall not exceed five PSIG at 300 GPM.

E. Manufacturer: AMES model 2000 SS (Basis of design), Watts Regulator, Febco.

2.17 DOUBLE CHECK VALVE WITH ATMOSPHERIC VENT

A. The double check valve atmospheric vent shall consist of two independently operating, spring loaded check valves, with intermediate vent.

B. Brass body construction with stainless steel internal parts and rubber seats. Integral strainer. ASSE standard 1012 approved. No special tools shall be required for servicing.

C. Provide installation that meets access requirements of local code amendments.

D. Water pressure drop through the assembly including shutoff valves shall not exceed 6 PSIG at 2 GPM.

E. Manufacturer: Watts 9D, or equal.

2.18 ACCESS DOORS

A. Provide access doors for mechanical systems in accordance with Division 08 - Openings.

B. Provide UL labeled access doors and panels when required for fire resistance of surrounding construction.

C. Provide key locks on access doors located in public areas below eight feet above finished floor.

D. Prime coat steel.

E. Coordinate location and size of access doors in walls, partitions, floors, and ceilings to correspond with valves, trap primers, cleanouts, and other devices requiring service or adjustment. Maintain any fire rating of the surrounding construction.

F. Manufacturers: Elmdor, KARP, Milcor, MIFAB.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions: Cover equipment and plug piping connections to protect components from construction dirt and debris.

B. Surface Preparation:

1. Verify that excavations are to required grade, dry, and not over-excavated.

2. Refer to Section 200556 - Interior Trench Excavation and Backfill.

3.2 INSTALLATION

A. Interface with Other Work:

1. Review architectural drawings. Coordinate locations of access panels prior to piping installation.

2. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Owner.

4. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 9 for instructions on painting and coordination.

B. Water Service Piping:

1. Install piping and plumbing products in accordance with UPC and manufacturer's instructions. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping and sprinkler heads per UPC, IBC, and ASCE-07; most conservative criteria shall govern.

2. Install piping to maintain headroom, conserve space, and not interfere with use of space.

3. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

4. At fixtures, install and connect hot water on left and cold water on right, as viewed when facing the fixture.

C. Valves:

1. Provide accessible ball type isolation valves at major piping branches, and on main lines as shown, and at all terminal devices.

2. Install balancing valves for hot water recirculation system to be accessible and adjustable.

D. Indirect-fired Water Heater: Install in accordance with UPC and manufacturer's instructions. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping and sprinkler heads per UPC, IBC, and ASCE-07; most conservative criteria shall govern.

E. Domestic Hot Water Circulation Pumps: Install in accordance with UPC and manufacturer's instructions. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping and sprinkler heads per UPC, IBC, and ASCE-07; most conservative criteria shall govern.

F. Domestic Hot Water Thermal Expansion Tanks: Field charge domestic hot water thermal expansion tank to match water service entry pressure.

G. Water Hammer Arresters: Install in accordance with UPC and manufacturer's instructions.

H. Trap Primer Valves: Install in accordance with UPC and manufacturer's instructions.

I. Water Meter: Install in accordance with manufacturer's instructions.

J. Cross Connection Protection Devices: Conform to applicable Code for installation of backflow prevention devices.

K. Provide finished products with protective covers during balance of construction.

L. Access Doors: Provide appropriate size and install such that plumbing features are readily accessible and maintainable.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.3 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.4 SITE QUALITY CONTROL

A. Site Tests:

1. Test water piping hydrostatically at 100 PSIG or 150 percent of working pressure, whichever is greater, for a period of four hours. Observe piping during this period and repair leaks and retest.

2. Air Test:

a. In general, air testing is not acceptable. In the event of low temperature conditions that would subject system piping to freezing, an equivalent air pressure test may be conducted in accordance with the Uniform Plumbing Code with prior Contracting Agency approval.
b. Test with clean air at 150 percent of system working pressure but not less than 75 PSIG or more than 150 PSIG. System shall hold pressure for not less than four hours. Inspect joints using leak detecting fluid or soapy water. Repair leaks and retest.
c. Observe necessary safety procedures when testing with air including, but not limited to, use of protective goggles or face shields. Only persons directly involved in testing procedure shall be within 20 feet of a pipe under pressure.

3. Test results shall be certified in writing as required by General Conditions. Include dates and sections tested, test pressure, test duration, printed names and signatures of person performing the test and Contracting Agency witnessing the test.

B. Inspection:

1. Arrange for inspections and provide notice to the Contracting Agency when the entire work or logical portions thereof, is ready for inspection.

3.5 SYSTEM STARTUP

A. Start-up and operate plumbing systems and equipment in accordance with the manufacturer's written installation and operation manual checklist.

B. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

C. Operationally test control and safety devices and record settings.

D. Submit a copy of start-up report that includes final settings and that indicates that the start-up of each piece of equipment has been completed.

3.6 CLEANING

A. Sterilization of Domestic Water Systems:

1. Sterilize each unit of completed supply line and distribution system with chlorine before acceptance for domestic operation.

2. Sterilization as described below or by the system prescribed by the American Water Works Association Standard C-651. Apply the amount of chlorine to provide a dosage of not less than 50 parts per million. Provide chlorine manufactured in conformance to the following standards:

   a. Liquid Chlorine: Federal Specification BB-C-120.
   b. Hypochlorite: General Specification O-C-114a, type 11, Grade B or Federal Specification O-X-602.

3. Introduce the chlorinating material to the water lines and distribution system after piping system has been thoroughly flushed. Maintain a contact period of not less than 24 hours. Flush the system with clean water until the residual chlorine content is not greater than 1.0 part per million.

4. Open and close valves in the lines being sterilized several times during above chlorination.

5. Certify in writing that sterilization has been completed in accordance with these requirements.

B. After construction is completed, clean and wipe down exposed surfaces of pumps, piping and appurtenances.

END OF SECTION 221100

SECTION 221300 - SANITARY WASTE AND VENT PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sanitary waste and vent pipe and fittings.
2. Acid resistant waste and vent pipe and fittings.
3. Cleanouts.
4. Sump pumps.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200529 - Mechanical Hangers and Supports
5. 200548 - Mechanical Vibration and Seismic Control
6. 200553 - Mechanical Identification
7. 200556 - Interior Trench Excavation and Backfill
8. 200700 - Mechanical Insulation
9. 221100 - Domestic Water Piping and Specialties
10. 224000 - Plumbing Fixtures
11. 253000 - Building Automation System Field Devices
12. 255000 - Building Automation Systems
13. 259000 - Sequence of Operation

1.2 REFERENCES

A. Codes and Standards:

1. International Building Code (IBC).

2. Uniform Plumbing Code (UPC).

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.

2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.

3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

4. ASA - American Supply Association.

5. CISPI - Cast Iron Soil Pipe Institute.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: This section describes specific requirements, products and methods of execution for sanitary waste systems and equipment.

B. Performance Requirements:

1. Sanitary waste systems shall perform quietly, with no objectionable vibration transmitted to the surrounding construction.

2. Replace piping that does not perform as intended with properly operating equipment.

3. Provide products with performance, output or salient features indicated or scheduled on the drawings.

1.4 PREINSTALLATION MEETINGS

A. Coordinate and sequence installation of sanitary waste and vent piping and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any plumbing components.

1.5 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed:

B. Product Data:

1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Clearly annotate literature to indicate specified salient features and performance criteria.

2. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.

C. Shop Drawings:

1. This Section shop drawings to be submitted under Section 200000 - Mechanical General Requirements.

2. Indicate pipe grade and direction of slope. Indicate elevation of piping at the beginning and end of each main, and at branch connections.

3. Coordinate exact locations of drains, floor penetrations and structural penetrations with applicable trades.

D. Manufacturer's Installation, Operation and Maintenance Manuals.

E. Test and Evaluation Reports:

1. Submit pressure test report.

2. Submit system flushing report.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general closeout submittal requirements for the items listed below, supplemented with the additional requirements listed:

B. Warranty Documentation.

C. Record Documentation:

1. Record actual dimensioned locations for buried or inaccessible piping.

2. Show actual cleanout locations and types.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by workmen usually employed and experienced with the trade.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged or otherwise unacceptable products from the project site when directed by the Contracting Agency.

B. Storage and Handling Requirements:

1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.9 WARRANTY

A. Refer to Section 200000 - Mechanical General Requirements for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 DRAINAGE PIPING, BURIED BENEATH AND WITHIN FIVE FEET OF BUILDING

A. Hub-and-Spigot Cast Iron Pipe and Fittings:

1. Manufacturers:

a. Charlotte Pipe and Foundry.
b. Tyler Pipe and Coupling.
c. AB&I Foundry.
d. Equal.

2. Pipe: ASTM A74, service weight.

3. Fittings: Cast iron.

4. Joints: ASTM C564, neoprene gasket system.

B. Hub-less Cast Iron Pipe and Fittings:

1. Manufacturers:

a. Charlotte Pipe and Foundry.
b. Tyler Pipe and Coupling.

c. AB&I Foundry.
d. Equal.

2. Pipe: CISPI 301, ASA group 022.

3. Fittings: Cast iron.

4. Couplings:

a. Manufacturers:
1). Husky Series 4000.
2). Approved equal.

b. Performance Requirements:
1). Submit independent test results demonstrating compliance with the following coupling minimum performance requirements.
2). Pipe deflection and shear load leakage tests independently tested by nationally recognized testing agency such as Factory Mutual Research. Results shall be presented with complete documentation of testing apparatus used to demonstrate the following levels of performance:

Pipe Size (inches)	Angle of Pipe Deflection Without Leakage at 10 PSI Internal Pressure	Shear Load Without Leakage at 10 PSI Internal Pressure
2	20	900
3	18	2100
4	10	1500
6	6	1500
8	8	1500
10	9	1700

3). Pressure Test: 13 PSIG internal pressure for 8 hours duration with no visible leakage.

c. Materials:
1). Heavy-duty 304-type stainless steel couplings and screws.
2). Minimum shield thickness: 0.015 inch.
3). Gaskets conforming to ASTM C564.

C. Acrylonitrile Butadiene Styrene (ABS)

1. Manufacturers:

a. Mueller Industries.
b. Charlotte Pipe and Foundry.
c. Valencia Pipe Company.
d. Equal.

2. Description: For use only where specifically shown on drawings.

3. Pipe: Schedule 40 conforming to ASTM F-628. NSF and IAPMO approved.

4. Fittings: ASTM D-2661, NSF and IAPMO approved.

5. Joints:

   a. Primer: ASTM F-656, NSF and IAPMO listed.
   b. Cement: ASTM D-2235, NSF and IAPMO listed.

2.2 DRAINAGE PIPING, ABOVE GRADE

A. Hub-and-Spigot Cast Iron Pipe and Fittings:

1. Manufacturers:

   a. Charlotte Pipe and Foundry.
   b. Tyler Pipe and Coupling.
   c. AB&I Foundry.
   d. Equal.

2. Pipe: ASTM A74, service weight.

3. Fittings: Cast iron.

4. Joints: ASTM C564, neoprene gasket system.

B. Hub-less Cast Iron Pipe and Fittings:

1. Manufacturers:

   a. Charlotte Pipe and Foundry.
   b. Tyler Pipe and Coupling.
   c. AB&I Foundry.
   d. Equal.

2. Pipe: CISPI 301, ASA group 022.

3. Fittings: Cast iron.

4. Couplings:

   a. Manufacturers:
      1). Husky Series 2000
      2). MG Coupling
      3). Any other manufacturer meeting the requirements of the contract documents. Substitution request not required.

   b. Description: No-hub cast iron pipe couplings conforming to standard CISPI 310.
   c. Materials:

1). Gaskets conforming to ASTM C564.
2). Stainless steel clamp-and-shield assemblies.

C. Copper Pipe, DWV: ASTM B75, ASTM B251, ASTM B302, ASTM B306.

1. Fittings: ASME B16.23 cast bronze, or ASME B16.29 wrought copper.

2. Joints: ASTM B32, lead-free solder, Grade 50B.

D. Copper Pipe, pumped application: Type L, ASTM B88.

1. Fittings: ASME B16.23 cast bronze, or ASME B16.29 wrought copper.

2. Joints: ASTM B32, lead-free solder, Grade 50B.

E. Acrylonitrile Butadiene Styrene (ABS):

1. Manufacturers:

a. Mueller Industries.
b. Charlotte Pipe and Foundry.
c. Valencia Pipe Company.
d. Equal.

2. Description: For use only where specifically shown on drawings.

3. Pipe: Schedule 40 conforming to ASTM F-628. NSF and IAPMO approved.

4. Fittings: ASTM D-2661, NSF and IAPMO approved.

5. Joints:

a. Primer: ASTM F-656, NSF and IAPMO listed.
b. Cement: ASTM D-2235, NSF and IAPMO listed.

2.3 CHEMICAL RESISTANT DRAIN AND VENT PIPING, BURIED

A. PPFR, Flame Retardant Polypropylene, Pipe:

1. Pipe: NSF listed type I, flame retardant schedule 40 polypropylene, conforming to ASTM D4101.

2. Fittings: NSF listed polypropylene, with molded-in-place heavy gauge nickel/chrome electrical resistance wire in the fitting body.

3. Joints: Electrical resistance fusion welded.

4. Manufacturer: Enfield Industrial Corp.

5. Trade name: Enfusion.

2.4 CHEMICAL RESISTANT DRAIN AND VENT PIPING, ABOVE GRADE

A. PPFR, Flame Retardant Polypropylene, Pipe:

1. Pipe: NSF listed type I, flame retardant schedule 40 polypropylene, conforming to ASTM D4101.

2. Fittings: NSF listed polypropylene, with molded-in-place heavy gauge nickel/chrome electrical resistance wire in the fitting body.

3. Joints: Electrical resistance fusion welded.

4. Manufacturer: Enfield Industrial Corp.

5. Trade name: Enfusion.

2.5 CHEMICAL RESISTANT DRAIN AND VENT ADAPTERS

A. Manufacturers:

1. Same as type of piping installed, where applicable.

2. Approved equal.

B. Use to connect pipes of same nominal size but different outside diameter, or pipes of different material (acid-resistant to cast iron, etc.).

2.6 CHEMICAL RESISTANT DRAIN AND VENT CLEANOUTS

A. Manufacturer: Same as type of piping installed, where applicable.

2.7 ADAPTERS

A. Manufacturers:

1. Romac.

2. Any other manufacturer meeting the requirements of the contract documents. Substitution request not required.

B. Use to connect pipes of same nominal size but different outside diameter or pipes of different material (cast iron to ductile iron, etc.).

C. Rigid sleeve type coupling, ductile iron center ring and end rings, elastomeric gaskets, corrosion resistant bolts or polyethylene encasement.

2.8 CLEANOUTS

A. Manufacturers:

1. Zurn.
2. Mifab.
3. J.R. Smith.
4. Any other manufacturer meeting the requirements of the contract documents. Substitution request not required.

B. Floor Cleanouts:

1. Cast iron body, bronze plug with neoprene gasket.
2. Adjustable head to match finished floor elevation.
3. Round, scoriated bronze top.
4. Where indicated, provide cleanout tops with tile-terrazzo insert or carpet insert to match surrounding floor finish.

C. Wall Cleanouts:

1. Cast iron body, recessed bronze plug.
2. Wall access panel or access cover with center screw.

D. Yard Cleanouts:

1. Cast iron body, bronze plug with neoprene gasket.
2. Heavy-duty access frame with anchor flanges and secured cover, fully surrounding and independent of cleanout.

2.9 ELEVATOR SUMP PUMPS

A. Provide packaged submersible pump, water/oil sensing and control system designed for the automatic pumping of water while preventing the pumping of oil.

B. Main control unit, junction box, pump, floats and sensor factory assembled and tested as a complete, ready-to-use system approved by a nationally recognized testing laboratory.

C. Sump Pump:

1. Approved to UL 778 standards.
2. Fully submersible type.

3. Type 304 stainless steel construction with Intake stand.

4. 50 GPM at 20 feet W.C.

5. Thermal and overload protection.

6. Rated for both continuously and intermittent operation.

7. Motor: 1/2 HP, 115 VAC, 1 Phase.

D. Packaged Control System:

1. Control Panel:

a. NEMA 4X enclosure with viewing window.
b. Separate LED status indicators for power available, pump running, oil fault, high water level, motor overload.
c. Probe sensitively adjustment.
d. Pump overload setting adjustment.
e. Audible alarm with silence and reset buttons.
f. Remote relay connection.
g. Multi-pin receptacle.
h. Power cord.

2. Junction Box:

a. NEMA 4X enclosure.
b. Multi-pin receptacle.
c. Pump power and multi-sensor connection.
d. Multi-pin connector cable.

3. Sensors:

a. Self-cleaning stainless steel oil sensor probe.
b. High level alarm float.
c. Pump “ON” float.
d. Sensor cabling.

E. Manufacturer: Stancor SE-50 or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Interface with Other Work:

1. Review architectural and millwork shop drawings. Confirm location of cleanouts and access panels prior to installation.

2. Coordinate and sequence installation of roof drains and piping with trades responsible for portions of this and other related sections of the Project Manual.

B. Protection: Cover equipment and plug piping connections to protect components from construction dirt and debris.

C. Surface Preparation:

1. Verify that excavations are to required grade, dry, and not over-excavated.

2. See Section 200556 - Interior Trench Excavation and Backfill.

3.2 INSTALLATION

A. Install plumbing systems in accordance with manufacturer's instructions and listing.

B. Provide finished products with protective covers during balance of construction.

C. Access Doors: Provide appropriate size and install such that plumbing features are readily accessible and maintainable.

D. Piping:

1. Grading: Minimum 1/4 inch per foot unless indicated otherwise on drawings and approved by AHJ for shallower slopes.

2. Install piping to maintain headroom, conserve space, and not interfere with use of space.

3. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

4. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

5. Where pipe support members are welded to structural building framing; scrape, brush clean, and apply one coat of zinc rich primer to welding.

6. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 09 - Finishes.

7. Connections:

a. Hub and hubless piping joints as specified above for underground piping.
b. Thread Joints: Assemble with TFE tape or approved non-hardening joint compound.
c. Solder Joints: Assemble with lead free solder.
d. Cement Joints: Assemble per manufacturer’s instructions.
e. Chemical resistant piping: Assemble in accordance with manufacturer’s recommendations.

E. Vents:

1. Install vents as indicated and as required by plumbing code. Add vents when field conditions increase the length of a trap arm or cause other changes in venting requirements.

2. Unless otherwise indicated, the portion of the vent extending through roof shall be increased in size from one foot below roof assembly to termination as defined below. Increase as follows:

   a. Vent size two-inch and under; vent thru roof three-inch.
   b. Vent size three-inch; vent thru roof four-inch.
   c. Vent size four-inch; vent thru roof six-inch.
   d. Vent size six inch & larger; vent thru roof same size.

3. Termination of Vent: As required by the Uniform Plumbing Code.

4. Chemical resistant vent shall not intersect vents for other services.

F. Cleanouts:

1. Provide as indicated on drawings.

2. If field conditions create additional offsets or increase length of piping shown, provide additional cleanouts as required by the Uniform Plumbing Code and AHJ.

G. Elevator Sump Pump:

1. Install sump pump in accordance with manufacturer's written installation instructions.

2. Coordinate elevator sump size and depth with submitted pump manufacturers written installation recommendations.

3. Coordinate elevator sump location with elevator hoist equipment so that water will drain to the sump from all areas of the elevator pit.

4. Coordinate with Divisions 26 for power, disconnects, and related electrical items.

3.3 REPAIR/RESTORATION

A. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

B. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

C. Substitute replacement parts from other manufacturers are not acceptable.

3.4 FIELD QUALITY CONTROL

A. Inspections: Arrange for inspections and provide notice to the Contracting Agency when the entire Work, or logical portions thereof, is ready for inspection.

B. Maintain current as-built drawings on-site recording including invert elevations, connections to fixtures, cleanouts, slopes, pipe sizes, and routing of pipes. Annotate sections of lines with dates when pressure tests have been approved by AHJ.

C. Pressure Tests:

1. Water Test: Test waste and vent system with water in accordance with the Uniform Plumbing Code.

2. Air Test:

a. In general, air testing is not acceptable. In the event of low temperature conditions that would subject system piping to freezing, an equivalent air pressure test may be conducted in accordance with the Uniform Plumbing Code with prior Contracting Agency approval.
b. Observe necessary safety procedures when testing with air including, but not limited to, use of protective goggles or face shields. Only persons directly involved in testing procedure shall be with 20 feet of a pipe under pressure.

3. Test results shall be certified in writing as required by General Conditions. Include dates and sections tested, test pressure, test duration, printed names and signatures of person performing the test and Contracting Agency witnessing the test.

D. Elevator Sump Pump Tests:

1. Manufacturer's Field Services:

a. Verify units are installed and operational in accordance with the manufacturer's written installation instructions.
b. Both the Contractor and Manufacturer's Representative(s) shall sign start-up and operational checklist to confirm proper unit installation and operation.

2. Test elevator sump pump and control system in accordance with the manufacturer's written test procedures or in accordance with the following. Document that operational test has been completed satisfactorily and submit documentation with closeout submittals.

a. Pump Test:
1). Verify oil sensor sensitivity setting is set to the 5 position.
2). Insert electrical plug into wall outlet. Power indicator will light.
3). Short oil sensor probe to pump housing with screw driver or shorting jumper.
4). With short in place, manually raise Pump On float. Pump should turn on. Pump Run indicator will light.
5). Lower float. Pump will continue to run.
6). Remove short. Pump will then turn off.

b. RMS Test/Oil Fault (Applicable only to systems connected to a central Building Automation Systems):
1). Manually raise float with NO short on probe. The RMS System should then be activated. Oil Fault indicator will light. Alarm will sound.
2). To reset RMS warning system, depress Reset button.
3). To silence alarm, depress Silence button.

c. High Alarm Test:
   1). Manually raise alarm float. The high level alarm will sound and the RMS system will activate. (High Level indicator will light.)
   2). Depress high alarm button to silence alarm.
   3). Lower alarm float and depress Reset button to reset the system.

d. Overload Settings: Verify that Overload Amp setting is set to manufacturer's requirements.

E. Verify penetrations are installed to maintain assembly integrity.

F. Coordinate with Divisions 26, 27 and 28 for power, disconnects, and related electrical items.

3.5 ADJUSTING

A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.

3.6 CLEANING

A. Flush drain piping to remove dirt and foreign debris from all systems.

B. Clean all exposed pipes, fittings, and materials.

C. Provide written certification which documents that the complete sanitary sewer systems have been flushed of foreign debris. Include date and printed names and signatures of person(s) performing the flush and Contracting Agency witnessing the flush.

3.7 CLOSEOUT ACTIVITIES

A. Start-up and operate plumbing systems and equipment in accordance with the manufacturer's written installation and operation manual checklist.

B. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

END OF SECTION 221300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Showers.
6. Supply and drain boxes.
7. Emergency fixtures.
8. Drinking fountains.
9. Tempering valves.
10. Hose bibbs and hydrants.
11. Floor drains and sinks.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200548 - Mechanical Vibration and Seismic Control
4. 200553 - Mechanical Identification
5. 200700 - Mechanical Insulation
6. 221100 - Domestic Water Piping and Specialties
7. 221300 - Sanitary Waste and Vent Piping and Specialties

1.2 REFERENCES

A. Codes and Standards:

1. Uniform Plumbing Code (UPC).

2. International Building Code (IBC).

3. American Society of Safety Engineers (ASSE).

4. Standard for Accessible and Usable Buildings and Facilities (ANSI A117.1).ASCE 07-05, Minimum Design Loads for Buildings and Other Structures.

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.

2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.

3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

4. GPF - Gallons Per Flush.

5. PSI - Pounds per Square Inch.

6. PSIG - Pounds per Square Inch Gauge.

7. “Handicap”, “handicapped”, or “ADA compliant”: Refers to fixtures that comply with the requirements of ANSI A117.1.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. This section describes specific requirements, products and methods of execution for plumbing fixtures.

2. Plumbing fixtures in potable water systems shall be lead free as defined by the 2011 Reduction of Lead in Drinking Water Act.

B. Performance Requirements:

1. Potable water systems shall perform quietly, with no objectionable vibration transmitted to the surrounding construction.

2. Replace piping and fixtures that do not perform as intended with properly operating piping and fixtures.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate and sequence installation of plumbing fixtures with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any plumbing components.

1.5 SUBMITTALS

A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed:

B. Product Data:

1. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.

2. Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Shop Drawings:

1. This Section shop drawings to be submitted under Section 200000 - Mechanical General Requirements.

2. Indicate dimensions and weights of fixtures and equipment, and placement of openings and holes.

D. Manufacturer’s Installation, Operation, and Maintenance (IO&M) Manual.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general closeout submittal requirements for the items listed below, supplemented with the additional requirements listed:

B. Warranty Documentation.

C. Record Documentation.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Company specializing in manufacturing the Products specified in this section with minimum three years’ documented experience.

2. Installers: Work shall be performed by workmen usually employed and experienced with the trade.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Handling Requirements:

1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

4. Replace damaged items with same item in new condition.

1.9 WARRANTY

A. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 FIXTURES

A. Traps, Stops and Supplies:

1. Provide traps, stops and supplies for fixtures.

2. Sink/lavatory P-Traps: 17-gauge chrome-plated tubular brass or cast brass.

3. Supplies: Flexible, stainless steel.

4. Stops: Quarter-turn, removable key type. Commercial quality metal components only; no plastic parts.

B. Escutcheons: Provide chrome plated wall escutcheons for pipe penetrations into walls.

C. Flush Valve Manufacturers: Sloan, Zurn, no substitutions.

D. Lavatory Faucets Manufacturers: Sloan, Delta, Chicago Faucets, no substitutions.

E. Carriers:

1. Manufacturer: J.R. Smith, Josam, Zurn, MIFAB.

2. Provide carriers for wall mounted fixtures.

F. Fixtures specified elsewhere, or otherwise furnished:

1. Provide appropriate strainer, tailpiece, trap, waste and supplies.

2. Rough in and connect only.

G. Handicapped Fixtures:

1. Provide fixtures in compliance with the appropriate standard listed in Part 1.

2. Provide fixtures operable with one hand without grasping, pinching or twisting of the wrist, and requiring not more than five pounds of operating force.

3. Handicap accessible lavatories and sinks: Where piping is exposed, provide fixture insulation assembly. Refer to Section 200700 - Mechanical Insulation.

H. Sensor operated fixtures: In addition to features described in the Fixture list, provide the following features:

1. General:

a. Provide with Infra-red sensors, solid state circuitry, battery operation.
b. Adjustable sensor range, variable time-out adjustment.
c. Filtered solenoid valves.

2. Flush valves:

a. Wall mounted sensors.
b. Over-ride button.

3. Hand faucet:

a. ADA compliant.
b. Splash proof electronic circuitry.
c. Aerator/spray head with pressure compensating flow control.
d. Trim plate for 4-inch center-set sink.
e. Under-counter control module.

4. Manufacturer: Sloan, Zurn, Symmons.

2.2 WATER CLOSETS

A. P-1 - Water Closet:
1. Fixture: Wall hung, siphon jet, elongated bowl, low consumption (1.28 gpf), 1-1/2 inch top spud. American Standard model Afwall Millennium.
2. Flush Valve: Sloan Royal model 8111-1.28.

3. Seat: Open front, commercial weight, heavy duty, solid plastic, stainless steel check hinge, without cover, white.
4. Carrier: Floor mounted. No residential.

B. P-1H - Water Closet:
1. Fixture: Wall hung, siphon jet, elongated bowl, low consumption (1.28 gpf), 1-1/2 inch top spud. American Standard model Afwall Millennium.
2. Flush Valve: Sloan Royal model 8111-1.28.
3. Seat: Open front, commercial weight, heavy duty, solid plastic, stainless steel check hinge, without cover, white.
4. Carrier: Floor mounted. No residential.
5. ADA: ADA compliant. Handicapped mounting height.

C. P-1B - Bariatric Water Closet:
1. Fixture: Floor mounted, siphon jet, elongated bowl, low consumption (1.28 gpf), 1-1/2 inch top spud, tested to support static load of 2,000 pounds. American Standard Right Width FloWise.
2. Flush Valve: Sloan Royal model 8111-1.28.
3. Seat: Open front, commercial weight, heavy duty, solid plastic, stainless steel check hinge, without cover, white.
4. ADA: ADA compliant. Handicapped mounting height.

2.3 URINALS

A. P-2H - Urinal:
1. Fixture: Siphon jet, vitreous china, low consumption (1.0 gpf). Integral flush rim, wall hangers, 3/4 inch top spud. American Standard model Trimbrook 1.0.
2. Flush valve: Sloan Royal model G2 8186-1.0.
3. Carrier: Floor mounted. No residential.
4. ADA: ADA compliant. Handicapped mounting height.

2.4 LAVATORIES

A. P-3H - Counter Lavatory:
1. Fixture: Counter mounted, vitreous china, self-rimming, 20-3/8 inch by 17-3/8 inch oval, front overflow, faucet holes on four inch centers. American Standard model Aqualyn.
2. Faucet: Sensor actuated, battery powered, deck mounted. Sloan model EBF-650.
3. Drain: Metal grid strainer.
4. Thermostatic mixing valve: ASSE 1070 certified and vandal resistant lockable temperature adjustment cap. Leonard model 270-LF or equal.
5. ADA: ADA compliant. Pipe drain for handicapped access.

B. P-4H - Wall Lavatory:
1. Fixture: Wall mounted, vitreous china, 20-3/4 inch by 18-1/4 inch, front overflow, faucet holes on four inch centers. Kohler Greenwich K-2032.
2. Faucet: Sensor actuated, battery powered, deck mounted. Sloan model EBF-650.
3. Drain: Metal grid strainer.
4. Thermostatic mixing valve: ASSE 1070 certified and vandal resistant lockable temperature adjustment cap. Leonard model 270-LF or equal.

5. Floor mounted carrier. No residential.
6. ADA: ADA compliant. Handicapped mounting height.

2.5 SINKS

A. P-5 - Exam Room Faucet:
   1. Faucet: Stainless steel, vandal proof wristblade handle, gooseneck spout, laminar flow, 4" fixed centers. Chicago Faucets GN12BVBSWGJKABCP.
   2. Thermostatic mixing valve: ASSE 1070 certified and vandal resistant lockable temperature adjustment cap. Leonard model 270-LF or equal.

B. P-6H - Double Compartment Sink:
   1. Fixture: Double compartment, 18 gauge, type 304 stainless steel, 19 inch by 33 inch overall, with 14 inch by 14 inch by 6-1/2 inch deep compartments, self rimming, sound deadened, with J-35 strainer. Just Manufacturing model DL-ADA-1933-A-GR.
   2. Faucet: Deck mounted, 1.8 GPM, one-hold mount with pull-out, rotating spout, 54 inch long hose, stream/spray adjustable function, and chrome finish. Delta model 4140-DST.
   3. Hot water dispenser: In-Sink-Erator Model H-770 190 degrees F, 115 volt, 750 watts.
   4. ADA: ADA compliant. Pipe drain for handicapped access.

C. P-7 - Laboratory Sink Faucet:
   1. Faucet: Stainless steel, 4-inch vandal proof wristblade handles, gooseneck spout, 2.2 GPM laminar flow outlet, 8-inch fixed centers, vacuum breaker. Chicago Faucets 786-GN8BVBE2-2CP.

D. P-9 - Mop Sink:
   1. Fixture: 24 inch by 24 inch with 10 inch high walls. Stainless steel drain body, factory installed. ProFlo Model PFMB2424S.
   2. Accessories:
      a. PFBG24V vinyl bumper guard.
      b. PFWG24S 20 gauge stainless steel back-wall panels.
      c. PFMBSSDRN 3-inch strainer and gasket for stainless steel drain.
      d. PF245 mop hanger with wall clamps.
      e. PFSSHE hose.
      f. PF296 hose bracket.
      g. PF1118 faucet with vacuum breaker, stops and bucket hook with brace.

E. P-11 - Sanitary Clinic Sink:
   1. Fixture: Wall-hung services sink, vitreous china, 25-1/4 inch by 21-1/8 inch. American Standard model 9512.999.020.
   2. Flush Valve: 6.5 GPF. Sloan Royal model 117-6.5.
   3. Faucet: Exposed yoke wall-mount utility faucet with vacuum breaker, bottom fork brace, 7-inch cast brass spout with vacuum breaker, ceramic disc valves, integral supply stops, offset shanks with integral check valves, vandal-resistant wrist blade handles, bucket hook, 3/4" threaded hose end, 1/2" NPT female inlets. American Standard model 8355 110.

2.6 SHOWERS

A. P-8H -Shower Trim:
   1. Fixture: Shower only trim, adjustable rotational limit stop, pressure balanced single handle mixing valve, 1.6 GPM plastic chrome plated shower head with adjustable spray. Shower: Zurn Z7000-HW2-H9. Control: Z7100-SS-LH.
   2. ADA: ADA compliant.

2.7 SUPPLY AND DRAIN BOXES

A. P-10 - Washer Machine Supply and Drain:
   1. Fixture: 20 gauge steel box and cover.
   2. Piping: 3/4-inch hose bibb outlet, 1/2-inch NPT or 5/8-inch OD sweat combo connection inlet, two inch drain.
   3. Guy Gray BB200TS.

2.8 EMERGENCY FIXTURES

A. EWS-1 - Emergency Eyewash:
   1. Fixture: Counter mounted, in-line strainer, swing down activation. Guardian model G1899L.
   2. Tempering valve: Guardian model G3600LF.

2.9 DRINKING FOUNTAINS

A. DF-1H - Drinking Fountain/Bottle Fill
   1. Fixture: Wall mounted dual height station with bottle filling station, polished satin finish stainless steel, hooded stream projector with push-button controls, perforated strainer, back panel. Oasis International, Model Aqua Pointe MMRSLEBF.
   2. Carrier: Floor mounted. No residential.
   3. ADA: ADA compliant.

2.10 TEMPERING VALVES

A. TV-1 - Thermostatic Tempering Valve:
   1. Separate high and low capacity thermostatic mixing valves, pressure regulating valve, integral check stops, supply and outlet pressure gauges.
   2. Rough bronze finish.
   3. Stainless steel, wall mount cabinet.
   4. Maximum pressure drop 5 psi at 48 GPM.
   5. Leonard Eco-Mix TM-186-1520B-LF.

2.11 HOSE BIBBS AND HYDRANTS

A. HB-1 – Hose Bib:
   1. Automatic draining, freezeless, with integral vacuum breaker.
   2. Flush mounted, with key operated hinged cover.

3. 3/4 inch hose connection.
4. Woodford model B65.

2.12 FLOOR DRAINS

A. FD-1 - Floor Drain:
   1. Fixture: Medium duty, cast iron body with adjustable flat bottom cast iron grate. Dome bottom strainer. No-hub outlet.
   2. Grate: 9-inch round top tractor grate.
   3. Trap primer connection.
   4. Zurn model Z525.

B. FD-2 - Floor Drain:
   1. Fixture: Cast iron body with adjustable, polished nickel bronze top. No-hub outlet.
   2. Grate: 5-inch round top. Free area (minimum) 5-inch round = 6-1/4 square inches. Secured by vandal-proof screws.
   3. Trap primer connection.
   4. Zurn model Z415-B.

C. FS-1 - Floor Sink:
   1. Fixture: Cast iron, 6 inch x 10 inch top, flanged receptor with acid resistant coated interior, nickel bronze rim. Dome bottom strainer. No-hub outlet.
   2. Grate: 1/2-inch nickel bronze grate.
   3. Trap primer connection.
   4. J.R. Smith 3300Y.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in plumbing system construction and fixture installation, and under the supervision of a qualified installation supervisor.

3.2 PREPARATION

A. Confirm location and size of fixtures and openings before piping rough-in and installation.

B. Verify that rough-ins have been provided, are correctly sized and are located within dimensional tolerances for fixtures to be installed prior to installation of fixtures.

C. Interface with other Work: Review Architectural drawings and millwork shop drawings to verify correct fixture locations.

3.3 INSTALLATION

A. Install piping and plumbing products in accordance with UPC and manufacturer's instructions. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping, and sprinkler heads per UPC, IBC, and ASCE-07; most conservative criteria shall govern.

B. Provide permanent metal and wire positioners, supports, and carriers to secure fixtures and piping rigidly in proper alignment without sway or sideplay.

C. Anchor fixtures securely to withstand applied vertical load of not less than 250 pounds on the front of the fixture, without noticeable movement.

D. Install fixtures plumb, level and to the finished architectural surface, so that the maximum gap between the fixture and the surface does not exceed 3/16 inch. Caulk the edge of the joint between fixture and surface with silicone or butyl type waterproof caulking compound.

E. Install and connect hot water on left and cold water on right, as viewed when facing the fixture.

F. Locate flush valve handles on handicapped accessible water closets on the wide side of the stall. Mount Accessible fixtures shown in the ADA guidelines to the heights indicated.

3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.5 SITE QUALITY CONTROL

A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer’s written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

3.6 ADJUSTING

A. Adjust functional components for proper operation in accordance with manufacturers’ recommendations, or as otherwise directed.

3.7 CLEANING

A. Clean fixtures and trim to a clean condition. Obtain a written certification from the Owner that this has been accomplished and accepted.

3.8 CLOSEOUT ACTIVITIES

A. Demonstration: Provide 2 hours of demonstration conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

B. Training: Provide 2 hours of operational instruction conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

END OF SECTION 224000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: General requirements and methods of execution relating to the testing and balancing of the mechanical systems provided on this project.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 232113 - Hydronic Piping and Specialties
5. 232123 - Hydronic Pumps
6. 233100 - Ducts and Accessories
7. 233400 - HVAC Fans
8. 233600 - Air Terminal Units
9. 233700 - Air Outlets and Inlets
10. 235223 - Cast Iron Boilers and Accessories
11. 236400 - Packaged Water Chillers
12. 237323 - Central Air Handling Units
13. 238123 - Dedicated Air-Conditioning Units
14. 238200 - Terminal Heating and Cooling Units
15. 238316 - Radiant Floor Heating Equipment
16. 254000 - Variable Speed Drives
17. 259000 - Sequence of Operations

1.2 REFERENCES

A. Codes and Standards:

1. National Environmental Balancing Bureau - Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

2. National Environmental Balancing Bureau - Testing, Adjusting, Balancing Manual for Technicians.

3. SMACNA - HVAC SYSTEMS Testing, Adjusting, and Balancing.

B. Abbreviations and Acronyms:

1. Refer to Division 01 for general abbreviations and acronyms.

2. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

3. TAB: Testing, Adjusting, and Balancing.

4. NEBB: National Environmental Balancing Bureau

C. Definitions:

1. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.

2. Accuracy: Capability of an instrument to indicate the true value of a measured quantity.

3. Adjusting: Varying of system flows by partially closing balancing devices, such as dampers, and valves, and varying fan speeds to achieve optimum system operating conditions within design and installation limitations.

4. Balancing: Methodical proportioning of air and hydronic flows through the system main, branches, and terminal devices using acceptable procedures to achieve the specified air or hydronic flow with testing and design limitations.

5. Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.

6. NEBB Certified TAB Firm: A Firm that has met and maintains all the requirements of the NEBB for Firm certification in TAB and is currently certified by NEBB. A NEBB Certified Firm shall employ at least on NEBB Qualified TAB Supervisor in the full time management position.

7. NEBB Certified TAB Report: Data presented in a NEBB Certified TAB Report accurately represents system measurements obtained in accordance with the current edition of the *NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems*. Variances from design quantities that exceed NEBB or contract document tolerances are to be noted in the TAB report project summary.

8. NEBB Qualified TAB Supervisor: Full time employee of the TAB Firm in a management position who has successfully passed the supervisor level written and practical qualification examinations and maintains the Supervisor re-qualification requirements of NEBB.

9. NEBB Qualified Technician: Full time employee of the TAB Firm who has met the technician level experience requirements of NEBB and has successfully passed the technician level written and practical qualification examinations. A NEBB Qualified TAB Technician shall be supervised by a NEBB Qualified TAB Supervisor. Supervision does not infer constant oversight; a NEBB Qualified Technician is capable of performing assigned tasks with periodic supervision.

10. Precision: Ability of an instrument to produce repeatable readings of the same quantity, or a tightly grouped set of values, under the same conditions.

11. Range: Upper and lower limits on an instrument's ability to measure the value of a quantity for which the instrument is calibrated.

12. Resolution: Smallest change in a measured variable that an instrument can detect.

13. Testing: Use of specialized and calibrated instruments to measure temperatures, pressures, rotational speeds, electrical characteristics, velocities, and air and hydronic quantities for an evaluation of flow conditions.

14. Testing and Balancing: As used in these specifications, testing and balancing refers to testing, adjusting, and balancing (TAB) as described in the above references.

15. TAB: A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as "Testing, Adjusting, and Balancing" and are described in this document.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: This section describes specific requirements, products and methods of execution for the testing, adjusting and balancing of the project.

B. Performance Requirements: Furnish the services of a qualified and approved TAB Firm to perform the work of this specification section.

C. The work of this section includes but is not necessarily limited to:

1. Test and balance fans and supply, exhaust and relief ventilating systems.

2. Test and balance hydronic heating and chilled water cooling systems.

3. Test and balance domestic hot water recirculation flow rate.

4. Test and balance room negative pressurization system.

5. Test and adjust fan filter differential pressure switches wherever provided.

6. Work directly with the control subcontractor to obtain proper system adjustments. This includes, but is not limited to:

    a. VAV box controller airflow coefficient adjustments.
    b. Airflow measuring device calibration adjustments.
    c. Fluid flow measuring device calibration adjustments.

7. Measure sound power levels if so directed.

8. Provide a final report.

D. The work of this section does not include:

1. Adjusting burners for proper combustion operation.

2. Liquid waste transfer system adjustment.

3. Refrigeration work.

4. Control system adjustments, unless noted otherwise herein.

1.4 PRE-BALANCING MEETING

A. Coordinate TAB work with other trades and requirements of other related sections of the Project Manual prior to commencing work.

B. Schedule a pre-balancing meeting one week prior to commencing work of this Section. Refer to Section 200000 - Mechanical General Requirements.

1.5 SUBMITTALS

A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data: Sample report forms and outlines indicating adjusting, balancing, and equipment data required prior to commencing work.

C. Certificates:

1. Submit the name and qualifications of TAB Firm for approval with general product submittals. Submit copy of TAB Firm's NEBB certification.

2. Submit the names and certifications of the Firm's NEBB Qualified TAB Supervisor and NEBB Certified Technician.

D. Balancing Report:

1. Submit a complete report of the testing and balancing of all devices in a format equivalent to that shown in the SMACNA HVAC Systems Testing, Adjusting and Balancing manual.

Compile the test data and submit eight copies of the complete test data for acceptance and/or analysis and recommendations.

2. Provide report in soft cover, letter size, comb bound binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include drawings within report.

3. Report Cover Sheet. Include the following data:

   a. Project Name.
   b. Project Address.
   c. Names of Architect and Engineer.
   d. Names of General Contractor and HVAC Contractor.
   e. Report date.
   f. Names of TAB technicians responsible for the measurements and report.

4. System Review Sheet:

   a. List air and hydronic systems balanced, with systems highlighted that were found to be performing outside design tolerances.
   b. Include a summary of problems encountered, deviations from design, deficiencies in performance, remaining problems, recommendations, and comments.

5. Instrument Calibration Report:

   a. Include a complete list of test equipment used, including apparatus manufacturer's name, model number, serial number, and date last calibrated.
   b. List the instruments used on the project during the balancing work, on an NEBB "Instrument Calibration Report" form, or equivalent form. This includes flow measuring hoods and other related devices.

6. Air Systems Report. Prepare a report for each air system balanced. Tabulate data separately for each system. Describe balancing method used for each system. At minimum, include the following:

   a. System Diagram: Include locations of air terminal units and pitot tube traverses. Include appropriate notes, static pressure reading locations, etc., taken during testing and balancing.
   b. Air Apparatus or Fan Test Report: Include pertinent data on the test report forms. If test data could not be measured, or is not applicable, indicate as such on report forms. List how each actual cfm measurement was obtained (duct traverse, total of outlet airflows, or a combination).
   c. Duct Pitot Tube Traverse Reports: Include actual temperature and pressure readings recorded at the time of testing and balancing.
   d. Air Outlet Test Reports: Include applicable A_k factors and terminal device sizes. If flow measuring hoods are used, indicate their use in the remarks column.
   e. Include complete identification of elements. Identify by box number, room name and number, air outlet symbol, orientation in room, etc., as necessary to clearly and positively identify the location of each element.

7. Hydronic Heating and Cooling System Reports. Prepare a report for each hydronic system balanced. Tabulate data separately for each system. Describe balancing method used for each system. At minimum, include the following:

    a. Schematic Diagram: Include heat exchange equipment and locations of flow measuring devices.
    b. Pump Test Report: Confirm test data was recorded and properly entered on form. Attach manufacturer's pump capacity curves, with the actual pump operating point plotted, to the test report form. List how the actual pump flow rate was determined (flow meter, pump curve, etc.).
    c. Primary Heat Exchange Equipment: Confirm that appropriate test data has been recorded for the boilers, heat exchangers, chillers, and other primary heat exchange equipment. List how the actual flow rate(s) of each item was determined.
    d. Terminal Heat Exchange Equipment: Confirm that heating coil and terminal unit temperatures and pressures were recorded and properly entered on form. List how each terminal unit flow rate was determined.
    e. Include complete identification of elements. Identify by equipment tag number, room name and number, baseboard symbol, orientation in room, etc., as necessary to clearly and positively identify the location of each element.

8. Reduced Size Drawings: Provide with air outlets and equipment identified to correspond with data sheets. Record actual locations of thermostats, flow measuring stations, and balancing valves with settings.

9. Reduced Sized Pressure Maps and/or Environmental Drawings: Provide marked up record drawings, recording actual room by room airflows, pressure relationships, and /or equipment offsets as indicated on contract drawings

1.6 QUALITY ASSURANCE

A. Qualifications:

1. The work described in this section shall be performed by a Firm certified by the National Environmental Balancing Bureau for air and hydronic balancing.

2. The Firm shall have a record of operation within Alaska for at least three years prior to bid date of this project and shall have demonstrated satisfactory completion of five projects of similar size and scope in the State of Alaska. Provide references if requested.

3. The Firm's Technician and Supervisor for this project shall be NEBB certified for their respective positions.

4. Bids by suppliers, contractors or any Firm whose principal business is not that of testing, adjusting, and balancing HVAC systems are not acceptable.

B. Balancing Standards:

1. Perform total system balance in accordance with NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

2. Maintain one copy of balancing procedural document on site.

3. Use standard NEBB forms.

C. Timing of Work:

1. Sequence work to commence after completion of systems. Do not begin balancing and testing until the systems are complete and in full working order.

2. Schedule the testing and balancing work in cooperation with other trades.

3. Schedule completion of testing and balancing before Substantial Completion of Project.

D. Construction team responsibility to TAB Agency: Refer to 200000 - Mechanical General Conditions.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify systems are complete and operable before commencing work.

B. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

C. Report defects and deficiencies that may preclude proper TAB of systems and equipment.

3.2 PREPARATION

A. Schedule work under the provisions of Section 200000 - Mechanical General Conditions.

B. Provide calibrated instruments required for testing, adjusting, and balancing operations.

C. Prior to starting work, review drawings and actual field conditions for additional balancing devices or components required for correct balance. Coordinate provision of additional balancing devices as required elsewhere in these specifications. Refer to Related Sections above.

D. Preliminarily adjust grille, register, and diffuser blades or pattern controllers per drawings. If airflow blow patterns are not shown on drawings, adjust for uniform diffusion pattern(s) or diffusion into long dimension of room.

3.3 SPECIAL TECHNIQUES:

A. Use instrumentation in accordance with NEBB requirements, calibrated to the accuracy standards specified by this organization.

B. Flow measuring hoods are acceptable for measurement of ceiling diffuser performance if used in a manner as recommended by the manufacturer and calibration and accuracy data is provided with the balancing report.

C. Upon request, make available to the Contracting Agency copies of current calibration certificates.

3.4 ACCEPTABLE CRITERIA

A. Systems will be considered balanced in accordance with NEBB *Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems* when the following conditions are satisfied:

1. Air Handling Systems:

a. Measured airflow quantities are within plus or minus 10 percent of design quantities. Deficiencies shall be noted in the TAB report.
b. There is at least one direct path with fully open dampers from the fan or terminal unit device to an air inlet or outlet. Additionally, if a system contains branch dampers, there will be at least one wide open path downstream of every adjusted branch damper.

2. Air Outlets and Inlets:

a. Measured airflow quantities total to within plus or minus 10 percent of design to space and individual outlets and inlets in space to within plus or minus 10 percent of design.
b. Spaces required to have positive or negative airflow as indicated on the Drawings have been verified and are correct.
c. Grilles, registers, and diffusers blades or pattern controllers are adjusted for uniform diffusion in the space. Re-adjust airflow patterns that result in airflow velocities greater than 50 FPM at 5 feet AFF.

3. Hydronic Systems:

a. Manually balanced systems:
   1). Measured fluid flow quantities are within plus or minus 10 percent of design.
   2). There is at least one direct path with fully open balancing valves from the pump discharge balancing valve (if present) to a terminal device. Additionally, if a system contains branch balancing valves, there will be at least one wide open path downstream of every adjusted branch balancing valve.

b. Automatically balanced systems: Pressure drops across system's automatic balance valves are within the manufacturer's recommended operating range for the device.

B. If systems or components cannot be adjusted to within specified tolerances:

1. Coordinate the replacement of sheaves, belts, or other components or devices needed for correct balance as required elsewhere in these specifications.

2. Note deficiencies in the TAB report.

3.5 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on equipment sheaves, belts, dampers, valves, air outlets and inlets and each system according to the procedures contained in the current edition of the NEBB *Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems* and this section.

B. Adjustments shall be made with air handler filters blanked off to create a filter pressure drop of 60 percent of the manufacturer's recommended filter final pressure. Where multiple filters are encountered each set shall be individually blanked off, for a cumulated pressure drop of 60 percent of each filters final pressure.

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

D. Permanently mark final settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Contracting Agency.

H. Schedule and provide assistance in final adjustment and test of fire alarm system with Authority Having Jurisdiction.

3.6 SITE QUALITY CONTROL

A. Make calibrated test instruments available to Contracting Agency to facilitate spot checks during testing and commissioning as appropriate.

B. Re-balance components or systems found to be out of tolerance at no additional expense to the Owner.

END OF SECTION 230593

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 231113 - FUEL OIL PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fuel Piping, Fittings and Accessories.
2. Fuel Transfer Pump.
3. Packaged Day Tank.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200529 - Mechanical Hangers and Supports
4. 200548 - Mechanical Vibration and Seismic Control
5. 200553 - Mechanical Identification
6. 231323 - Aboveground Fuel Oil Storage Tanks
7. 235223 - Cast Iron Boilers and Accessories
8. 259000 - Sequence of Operations

1.2 REFERENCES

A. International Mechanical Code (IMC).

B. International Fire Code (IFC).

C. National Fire Protection Association (NFPA) Standards:

1. NFPA 30 - 2003: Flammable and Combustible Liquids Code.
2. NFPA 31 - 2001: Installation of Oil Burning Equipment.

1.3 SYSTEM DESCRIPTION

A. The work includes provision of the fuel oil distribution system from the main fuel storage tank to the day tank, and from the day tank to the oil burning apparatus connections. In general, oil burning equipment is specified elsewhere.

1.4 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements.

B. Product Data:

1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria for each product specified.

C. Shop Drawings:

1. Provide scaled shop drawings.

2. Incorporate the following installation information:

a. Storage tank, day tank and fuel burning equipment locations and pipe connection points.
b. Fuel pipe routing, elevations and slope to drain indication.
c. Fuel piping isolation valve locations and accessories.

D. Quality Assurance/Control Submittals:

1. Design Data, Test Reports: Field quality control test reports.

2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:

a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
b. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
   1). Printed names and signatures of the installers.
   2). Documentation from Manufacturer's representative and Contracting Agency that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.

c. Include with the checklist a list of applicable programmable control setpoints with their current programmed settings.

E. Operation and Maintenance (IO&M) Manuals:

1. Provide copies of approved submittal information for inclusion within the project IO&M Manual.

2. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.

1.5 QUALITY ASSURANCE

A. Pre-Installation Meetings: Coordinate installation of fuel system components with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any fuel system components.

B. Regulatory Requirements: Products Requiring Electrical Connection - Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Protection:

1. Outside the general construction zone, store products in covered storage area protected from the elements until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.7 WARRANTY

A. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

B. Submit required documentation to the Manufacturer’s Representative to validate manufacturer’s warranty. Obtain written confirmation of receipt.

C. Provide Contracting Agency with one copy of required warranty documentation with written confirmation of receipt from the Manufacturer’s Representative.

PART 2 - PRODUCTS

2.1 FUEL PIPING AND FITTINGS

A. Above grade:

1. Carbon Steel Product Line Pipe and Fittings:

a. Schedule 40 black steel.
b. 3,000 lb forged steel socket weld couplings or schedule 40 butt weld fittings.

2. Vent Piping and Fittings:

a. Schedule 40 galvanized steel.
b. Galvanized malleable iron threaded fittings.

B. Buried:

1. Double-Walled Flexible Product Line Piping Systems:
   a. Description: UL listed pre-engineered system for underground transfer of flammable liquids. The double-walled piping system shall consist of flexible inner primary pipes contained within a flexible outer secondary containment pipe. Piping runs shall be continuous with no fittings or piping connections, for either the primary or secondary containment pipe, buried below grade. The secondary containment system shall provide water tight containment of the primary piping.
   b. Product compatibility: Components of the double-wall piping system shall be compatible with No. 1 and No. 2 fuel oil.
   c. Corrosion resistance: Components of the double-wall piping system shall be made of noncorrosive materials, or if metallic, such as fittings and couplings, isolated from corrosion causing elements.
   d. Monitoring capability: The design of the secondary containment system shall permit any leak in the primary piping system to flow from its source to the AST-1 base pad accessible leak detection sump which shall be fitted with an electronic leak detection system.
   e. Manufacturer: OPW FlexWorks or approved equal.
2. Lined access pipe:
   a. Four (4) inch ID HDPE corrugated flexible conduit.
   b. Eighteen (18) inch minimum bend radius.
   c. Capable of withstanding H-20 loading requirements when installed in accordance with the manufacturer’s installation instructions.
   d. Manufacturer: OPW AXP40 or approved equal.
3. Appurtenances:
   a. Provide additional components from the same manufacturer as required for a complete pre-engineered system for the configuration as shown. Products to include, but not limited to:
      1). Pipe couplings and fittings.
      2). Test boots.
      3). Transition assemblies.

2.2 TRANSITION SUMPS

A. Provide one-piece polyethylene transition sumps for AST-1 above ground piping transition to below ground piping system and for shallow bury intermediate leak detection sumps. Compatible with buried fuel transfer piping system

B. Manufacturer: OPW TSS Series or approved equal.

2.3 TRACER TAPE

A. Underground tracer tape shall be a minimum of 6 inches wide and labeled, "CAUTION - BURIED FUEL LINE BELOW". Provide tracer tape for buried piping, except under building slabs. Tape shall be a maximum of 24 inches above top of buried pipe and run continuous along the length of pipe.

B. Tracer tape used for non-metallic lines shall be metalized to allow pipe location without excavation. Locate tape approximately 6 inches from surface grade.

C. Manufacturer: Calpico, Inc. Type II (detectable), or approved equal.

2.4 THREAD SEALANT

A. Threaded connections are to be sealed with a UPC listed, lead-free, paste thread sealant compatible with the product and piping materials specified.

B. Threaded connections which must be disassembled for periodic maintenance shall be sealed with a UPC listed, lead-free, non-seizing type, paste thread sealant compatible with the product and piping materials specified.

C. Manufacturer: Real-Tuff™, Grrip™, or approved equal.

2.5 VALVES

A. Isolation Valves:

1. Size: 1/2 inch to 2 inch pipe size.

2. Ball type, carbon steel, regular port, WOG rated.

3. Chrome plated ball and stem.

4. Blow-out proof, grounded stem.

5. PTFE resilient seats and seals.

6. Zinc plated handle with rubber handle cover.

7. Manufacturer: Crane Tork-Seal No. 940, threaded, 2000CWP/150SWP, or approved equal.

B. Check Valves:

1. Size: 1/2 inch to 3 inch pipe size.

2. Screwed cap, Y pattern, swing type, bronze, threaded, WOG rated.

3. Vertical or horizontal installation.

4. Manufacturer: Crane No. 37, threaded, or approved equal.

C. Fusible Valves

1. UL listed.

2. Bronze body.

3. Automatic shutting at 165 degrees F.

4. Self-adjusting stuffing box.

5. Backseat feature.

6. Threaded, flared or combination fittings.

7. Manufacturer: Firomatic, or approved equal.

D. Thermal Relief Valves:

1. ASTM code stamped or UL approved for petroleum use.

2. Size: 1/2 inch MPT by 3/4 inch FPT.

3. Cast steel valve body with stainless steel trim.

4. Closed Cap, Open lift lever, packed lift lever.

5. Nitrile O-rings.

6. Manufacturer: Hydro-Seal Valve Company, Inc., or approved equal.

E. Oil Safety Valves:

1. UL listed.

2. Provide positive shut-off of fuel supply in the event of downstream pipe failure.

3. Manufacturer: Webster Model OSVA or approved equal.

F. Anti-siphon Valves:

1. Zinc plated, ductile iron body, zinc plated spring, and fluorocarbon disc seal.

2. Automatically shuts off the oil flow in the event of a broken or left open oil suction line.

3. Adjustable and lockable mechanism to allow various liquid head pressure settings within the valve range.

4. Manufacturer: Franklin Fueling Systems or approved equal.

2.6 FILTERS

A. Suitable for pressure type burners, UL listed.

B. Filter capacity: 25 microns.

C. Manufacturers: General Filter, Firomatic, or approved equal.

2.7 GAUGES

A. 2-1/2 inch diameter gauge, suitable for oil service.

B. Accuracy at two percent of range.

C. Select pressure range for normal; indicate in the middle third of range.

D. Manufacturer: Trerice or approved equal.

2.8 REMOTE FUEL OIL PUMP PACKAGE

A. Provide remote fuel oil pump package with controls compatible with the interior day tank.

B. NEMA-4X (stainless steel) tank mounted cabinet.

C. Hydraulic gear fuel oil supply pump with the performance and electrical characteristics as scheduled.

D. Pump motor starter with overload relay.

E. Pump motor disconnect with door handle interlock.

F. Pump inlet and outlet ball type shut-off valves.

G. Priming tee and check valve assembly.

H. Pressure relief valve.

I. Fuel strainer.

J. Manufacturer: Simplex or approved equal.

2.9 ELECTRONIC LEAK DETECTION SYSTEM

A. Provide AST-1 mounted leak detection alarm panel with AST-1 interstitial space and two transition sump leak detection probes (3 total). System to include the following features:

1. U.L. listed.

2. Alarm panel with intrinsically safe relays housed in a NEMA-4X enclosure.

3. Alarm panel to include status lights, alarm buzzer and push-to-test/alarm silence button.

4. Auxiliary alarm contact for connection to building automation system (BAS).

5. Leak detector switches with Buna N float and weighted collar. Mfr: Gems, Model LS-750 Series.

B. Manufacturer: Anchorage Tank and Welding, Inc., Model: Anchorage Tank Monitor 1 or pre-approved equal.

2.10 PACKAGED DAY TANK (DT-1)

A. Provide packaged day tank system of the size, capacity, and with tappings as scheduled. Construct day tank to UL standards and provide UL label.

B. Packaged day tank to include the following standard equipment:

1. Seam welded steel tank with removable top plate, steel channel feet with mounting holes. Epoxy coated tank interior. Enamel coated tank exterior.

2. Welded flange pipe and vent tappings.

3. Fully enclosed secondary containment basin with float switch sensor and quick drain.

4. 7 GPM hydraulic gear over-fill return pump (1/2 HP, 120 VAC).

5. 1 GPM hand pump.

6. 2 suction tubes.

7. 2 inch manual locking fuel fill cap.

8. Vent cap.

9. Intake solenoid valve.

C. Packaged day tank to include the following control devices and alarms:

1. Power transformer.

2. Power available pilot light.

3. Pump “Run-Off-Automatic” mode selector switch.

4. Pump running light.

5. Remote high and low fuel level alarm dry signal contacts with auxiliary relay for connection to BAS.

6. Local/remote low and high fuel level alarms.

7. High fuel level automatic pump stop.

8. Electric level gauge.

D. Manufacturer: Simplex or pre-approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fuel transfer containment piping:

1. Install complete fuel transfer and leak detection system in accordance with the manufacturer’s written installation and testing instructions.

2. Grade underground containment piping at a minimum slope of 1/8 inch per foot to drain to leak detection sumps.

3. Terminate containment piping system both at the above ground storage tank (AST-1) and at the mechanical room floor penetration with termination assemblies provided by the containment piping system manufacturer.

4. Provide test fittings and test donuts at each leak detection sump termination point.

B. Leak detection sumps:

1. Locate a leak detection sump buried and adjacent to base of above ground storage tank (AST-1) and at the mechanical room as shown.

2. Grade fuel transfer containment piping to drain to leak detection sumps as shown.

3. Install leak detector switches in each sump using internal support brackets such that switches are in contact with base of the sump. Route detector switch cables in conduit to leak detection monitoring panel located at AST-1.

C. Tank Connections: Terminate fuel oil supply and return lines at threaded tank bosses as shown.

D. Above ground and interior fuel oil piping:

1. Provide socket welded steel fuel piping routed as shown.

2. Support piping with Unistrut or equal, pre-engineered mechanic support system. Provide rubber inserts provided by the manufacturer at each pipe clamp.

3. Label fuel oil piping with self-adhesive pre-manufactured labels. Refer to specification 200553 - Mechanical Identification.

E. Day tank:

1. Install and test packaged day tank in accordance with the manufacturer's installation, maintenance and operating instructions.

2. Position tank for full accessibility.

3. Anchor day tank base to concrete housekeeping pad using appropriate concrete anchor bolts. Coordinate with section 200548 - Mechanical Vibration and Seismic Control.

4. Connect alarm monitoring contact(s) to building automation system (BAS).

F. Equipment Connections:

1. Provide the final operating connection to fuel oil burning equipment in accordance with the specific equipment manufacturer's installation instructions.

2. Provide leak tight, sheetmetal drip pans with 4 inch raised and rolled rims under each fuel oil burner, filter assembly, and at any additional location susceptible to fuel oil leakage.

3.2 FIELD QUALITY CONTROL

A. Air Tightness Testing:

1. To prevent storage tank over-pressurization during associated fuel pipe pressure testing:

a. Disconnect product lines to be pressure tested at their storage tank connections and plug exposed tank openings with threaded plugs prior to connection of the pressure source.
b. Upon completion of the pressure test, de-pressurize product lines to ambient pressure, disconnect the pressure source and reassemble product pipes to their appropriate tank connections.

2. Fuel Pipe Testing: Upon completion of the transfer piping installation and prior to backfilling (for underground piping), subject fuel piping to a 20 PSIG air tightness test, soaping joints and inspecting for bubbles. If lines have held product, or after backfilling, test lines hydrostatically to 110 percent of operating pressure, but not less than 20 PSIG.

3. Secondary Containment System Testing: Upon completion of the transfer piping installation and prior to backfilling, provide an air tightness test of the transfer piping secondary containment system in accordance with the manufacturer's written test instructions.

B. Tank testing:

1. Tanks are to be shop pressure tested prior to delivery in accordance with UL 142. The listing mark of the Underwriters Laboratories, Inc. on a tank shall be evidence of compliance with this test.

2. Where the vertical length of fill and vent pipes is such that when filled with liquid, the static head imposed on the bottom of the tank exceeds 10 psig (23 ft WC), hydrostatically pressure test the tank and related piping to the pressure equal to the static head imposed.

C. Anti-siphon valve testing: Test for proper functioning upon completion of installation. Adjust valve as needed for proper operation.

D. Documentation. Document field testing to include the following:

1. Test Date and time.

2. Company and Person(s) conducting the test.

3. Test pressure and duration.

4. Contracting Agency witnessing the test.

5. Legible signatures of all parties involved in the test certify that the test was satisfactorily completed as specified and in accordance with the manufacturer's written test procedures as applicable.

6. Submit test documentation in accordance with submittal requirements.

3.3 ADJUSTING

A. Adjust systems in accordance with the manufacturer's written operation instructions.

B. Adjust oil return line safety valve setpoint from the nominal setpoint indicated on the Drawings to achieve an operating pressure of 2 psig at the boiler header piping.

C. Anti-siphon valve: Adjust valve as needed for proper operation

3.4 CLEANING AND PAINTING

A. Verify day tank interior is clean and free of debris prior to initial fill tank.

B. Clean inside transfer pump enclosures, secondary containment voids and any other accessible, covered spaces prior to initial fuel fill and again prior to substantial completion.

C. Clean exterior piping and equipment surfaces prior to substantial completion.

D. Paint new interior and exposed exterior fuel oil piping with one coat of a suitable rust-inhibiting primer and one final coat of heat-resistant black enamel paint to provide a uniform appearance. Paint piping prior to installing permanent piping clamps so that all piping surfaces are painted.

3.5 DEMONSTRATION AND STARTUP

A. Startup fuel transfer system as part of boiler startup in accordance with the manufacturer's written start-up procedures. Test normal modes of operation, as well as, emergency overflow return pump operation.

B. Demonstrate proper operation of the systems to the satisfaction of the Contracting Agency.

C. Provide written documentation that demonstration and start-up of the systems and equipment has been satisfactorily completed.

END OF SECTION 231113

SECTION 231323 - ABOVEGROUND FUEL OIL STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aboveground fuel oil storage tanks

2. Tank appurtenances.

B. Related Sections: 200000 - Mechanical General Requirements.

1.2 DESCRIPTION

A. This section describes specific requirements, products, and methods of execution relating to the aboveground fuel oil storage tank for this project.

1.3 SCOPE

A. Provide aboveground fuel oil storage tank (AST) systems in accordance with the drawings, the referenced publications, and the manufacturer's written installation instructions, checklists, and warranty requirements for each system component. AST systems include the products, equipment, and systems identified in this section.

1.4 CODES AND STANDARDS

A. Provide work relating to aboveground storage tanks and appurtenances in accordance with the minimum provisions of the following codes and standards:

1. International Fire Code.

2. International Mechanical Code.

3. National Electrical Code.

4. National Fire Protection Association (NFPA) Standard 30: Flammable and Combustible Liquids Code.

5. Underwriters Laboratories Standard UL 142: Steel Aboveground Tanks for Flammable and Combustible Liquids.

1.5 QUALITY ASSURANCE

A. Installation of tanks shall be in accordance with the tank manufacturer's written installation instructions.

B. Work and materials shall be in accordance with requirements of the applicable State and local Codes, regulations and ordinances, and the rules and regulations of other Authorities Having Jurisdiction. Nothing in drawings and specifications shall be construed to permit work not in conformance with applicable codes, rules, and regulations.

C. Where drawings or specifications call for a material or construction of a better quality or larger sizes than required by the above-mentioned Codes, rules and regulations, the provision of the specifications shall take precedence.

D. The Contractor shall furnish without any extra charge any additional material and labor when required for compliance with these Codes, rules and regulations, even though the work may not be mentioned in the specifications or shown on the drawings. It shall be the responsibility of the successful bidder to bid in accordance with the minimum requirements of the applicable codes, rules, and regulations.

E. Electrical motors, starters, controls, devices and wiring shall comply with standards of NEC and shall be UL listed and so identified.

1.6 DRAWINGS

A. Drawings are diagrammatic and show the general design, arrangement and extent of the systems. Do not scale or attempt to use drawings for roughing-in measurements or as shop drawings.

B. Investigate capacity and space requirements of the proposed equipment before submitting shop drawings.

C. Obtain field measurements and prepare detailed shop drawings for submittal, demonstrating coordination with equipment and systems being provided by trades.

D. Where conditions necessitate rearrangement or equipment and/or systems, prepare and submit to the Contracting Agency for review, drawings of the proposed rearrangement. Due to the scale of the drawings, it is not possible to show all offsets, fittings, and accessories which may be required.

1.7 SUBMITTALS

A. Product Data:

1. Provide submittal data in accordance with the general requirements of Section 200000 - Mechanical General Requirements. Include the additional submittal information specific to the equipment specified by this section as followings:

a. Provide manufacturer’s literature that fully demonstrates compliance with the manufacturing methods, appurtenances and salient features specified.
b. Mark manufacturer’s literature to indicate exactly those items that are to be provided and cross out unrelated or non-applicable items. In addition, submit manufacturer's detailed installation instructions on equipment and materials submitted.

B. Substitutions: Additional costs associated with design modifications as a result of proposed product substitutions shall be borne by the Contractor.

C. Shop Drawings:

1. Submit shop drawings for the above ground storage tank which show principal dimensions, materials, fitting locations, sizes and thread type and anchoring method.

2. Coordinate shop drawings with work of other trades.

D. Operation and Maintenance (IO&M) Manual:

1. Provide a complete copy of the manufacturer’s written installation, operation and maintenance manual to include the following information:

a. Manufacturer’s descriptive literature.
b. Installation instructions.
c. Operating instructions.
d. Troubleshooting guide.
e. Preventative maintenance requirements.
f. Complete parts list.
g. Recommended spare parts list.

2. Neatly annotate the IO&M manual to clearly indicate information applicable to the equipment installed.

E. Closeout submittals:

1. Project record drawings: Annotate a clean copy of the project Contract Drawings to clearly indicate the actual installation of the equipment.

2. Provide a certificate from the Manufacturer's Representative indicating that the equipment and systems provided have been installed and are operational in accordance with the manufacturer’s written installation, operation and maintenance manual and the adjustment requirements required by the Part 3.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

2. Acceptable Installers: Minimum three years' experience in the installation and start-up of fuel oil systems.

B. Pre-Installation Meetings: Coordinate installation of pumps and associated piping and valves with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

C. Regulatory Requirements: Products Requiring Electrical Connection - Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Protection:

1. Outside the general construction zone, store products in covered storage area protected from the elements until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.10 WARRANTY

A. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

B. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.

C. Provide to the Contracting Agency one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

PART 2 - PRODUCTS

2.1 GENERAL

A. Underwriters Laboratories under UL142 Standard shall list the entire tank system, including the skid and secondary containment, for safety as a complete and indivisible unit. The skid mounted tank assembly shall bear the UL listing marking.

2.2 DOUBLE WALLED ABOVEGROUND TANKS FOR THE STORAGE OF PETROLEUM PRODUCTS

A. Tank:

1. Above ground fuel oil storage tanks shall be of double wall (Type I), welded steel construction and guaranteed compatible with the contents indicated in the Drawings.

2. Construction of the outer tank shall be separate but in intimate contact with the inner tank and shall encompass 300 degrees of the circumference. The inner and outer tank shells and the tank heads shall be as required by the UL 142 listing. Head bracing shall be as required by the standard.

3. Flat unflanged heads shall not be permitted on either inner or outer tanks.

B. Skid:

1. The skid rails shall be constructed of structural steel beam and shall be listed as an integral part of the tank.

2. Skid supports shall be constructed of plate steel, equal in thickness to the inner tank with a 90 degree bent edge, 1 inch wide, at each side of the structural support. Supports shall be placed directly under the inner tank heads and thereafter, evenly spaced along the tank. Spacing between supports shall not exceed 69 inches. The skid supports shall be attached to a 12-inch wide saddle pad attached to the outer tank shell that is of sufficient length to encompass the bottom 120 degrees of the tank.

3. A capped length of schedule 80 pipe shall be attached to each end of the skid to function as a tow bar when the tank is empty. The skid rail beam member shall encircle the full 360 degrees of the tow bar.

C. Weld joints:

1. Joints on the inner and outer shell and tank heads shall be as required by the UL 142 listing. In addition, non-structural external seams shall be seal welded before painting.

2. Weld spatter shall be removed and sharp edges shall be rounded and smoothed by grinding.

D. Tank attachments and penetrations:

1. Piping penetrations shall be made through the top of the tank only with sizes and locations as shown on the Drawings.

2. Secondary containment shall allow for the full recovery of a release from the inner tank into the annular space between the inner and outer tanks.

3. An additional fitting shall be incorporated into the tank (typically located on the top of the opposite end of the tank from the monitoring port) to allow flushing of any product which may accumulate as a result of release or an accidental fill of the annular space.

4. Each tank shall be equipped with lifting lugs adequate for the safe handling of the tank during installation. Each lifting lug must be designed to support the total weight of the empty dual wall tank system. A minimum of two lifting lugs shall be provided on tanks having a rated capacity of more than 1,100 gallons of product.

E. Inspection and testing:

1. Prior to painting, each tank shall be tested per UL 142 by the tank manufacturer to determine that the tank does not leak.

2. Rewelding shall repair leaks and the tank retested until no leaks are present.

F. Finishes:

1. Exterior surfaces shall be cleaned and prepared by sandblasting in accordance with Steel Structures Painting SSPC-3 requirements and thereafter painted in accordance with the manufacturer's recommendations, with Contracting Agency's approval.

2. It shall not be necessary to blast and paint the interstice.

G. Warning signs and placards:

1. The tank shall be provided with appropriate, permanently attached, warning labels and/or placards in accordance with International Fire Code requirements, based on nominal tank capacity and the contents being stored.

H. Miscellaneous:

1. Thread protectors or plugs shall be installed in each tank opening during storage and shipment to the site.

2. Protectors and plugs shall include vent holes to allow pressure venting of the tanks while in storage.

3. Installation and field-testing shall be per Steel Tank Institute F921 Standard.

2.3 TANK APPURTENANCES

A. General: Tank appurtenances shall be as shown on drawings and specified below. Appurtenances shall be Underwriters Laboratories (UL) listed for storage of petroleum products. Appurtenances shall, where practical, be shop installed, tested and painted/coated with the same coating provided for the tank before shipment to the site.

B. Containment Manhole Fill Box:

1. Welded steel construction.

2. Lockable, hinged. weather-tight gasketed lid.

3. Two 4 inch tank bosses.

4. Drain valve to tank.

5. Manufacturer: Anchorage Tank and Welding Inc., Greer, Ace Tank.

C. Suction Foot Valve:

1. 3/4 inch, double poppet.

2. Bronze body and poppet.

3. 8 mesh screen.

4. 3/4 inch FPT connection.

5. Manufacturer: OPW 92-0033, or approved equal.

D. Fill Limiter Assembly:

1. Assembly shall be compatible with 4-inch tank opening.

2. 2-inch diameter dry-break coupler with dust cap.

3. Aluminum fill tube with adjustable collar, 4 inch FPT connection.

4. Float valve with positive shut-off.

5. Aluminum drop tube.

6. Size fill pipe and drop tube for 90 percent product level shutoff based on tank diameter as per manufacturer instructions. Drop tube shall extend to within 6 inches of tank bottom.

7. Manufacturer: Clay and Bailey F-30, Morrison 9095A, or approved equal.

E. Emergency Vent:

1. Cast iron body.

2. Lid design that minimizes weather effects.

3. Brass fire/spark arresting screen.

4. Manufacturer: Clay and Bailey No. 368, or approved equal.

F. Normal Vent:

1. Aluminum body and cap for upward venting.

2. Removable brass 40 mesh screen.

3. 2-inch size with threaded NPT or Setscrew connection.

4. Manufacturer: OPW 23-0033, Clay and Bailey No. 395, Emco Wheaton MR 354, or approved equal.

G. Mechanical Level Gauge:

1. For horizontal or vertical tanks up to 12 feet high.

2. Measures in feet/inches.

3. Continuous level indicating float gauge.

4. 1/4 inch accuracy.

5. 2 inch MPT connection.

6. Manufacturer: Morrison, Model 818 "clock gauge", or approved equal.

H. Bushings:

1. Double tapped, cast iron.

2. Duplex bushings shall be 2 x 1/2 x 1/2 inches.

3. Manufacturer: Morrison No. 184, 184-D, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install AST system in accordance with the drawings, the referenced publications, and the manufacturer's written instructions, checklists, and warranty requirements for each system component.

3.2 TANK TESTING

A. Tanks are to be shop tested before being placed in service in accordance with UL 142. The listing mark of the Underwriters Laboratories, Inc. on a tank shall be evidence of compliance with this test.

B. Where the vertical length of fill and vent pipes is such that when filled with liquid, the static head imposed on the bottom of the tank exceeds 10 PSIG (23 ft WC), the tank and related piping shall be tested hydrostatically to the pressure equal to the static head imposed.

C. To prevent storage tank over-pressurization during associated product pipe pressure testing.

1. Disconnect product lines to be pressure tested at their storage tank connections and plug exposed tank openings with threaded plugs prior to connection of the pressure source.

2. Upon completion of the pressure test, de-pressurize product lines to ambient pressure, disconnect the pressure source and reassemble product pipes to their appropriate tank connections.

3.3 ADJUSTING

A. Adjust fuel limiter assembly to provide fuel fill shut-off at 90 percent tank capacity in accordance with the fuel limiter assembly installation and operation instructions. Document fuel limiter valve elevation (in inches) with respect to the inside base of the tank.

B. Adjust fuel tank level gauge assembly to provide accurate fuel level measurement in accordance with the fuel gauge assembly installation and operation instructions. Verify that fuel level gauge accuracy is within the manufacturer's listed tolerance during initial fill. Document that fuel level gauge accuracy has been verified.

END OF SECTION 231323

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 232113 - HYDRONIC PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings for:

   a. Hydronic heating piping.
   b. Equipment drains and overflows.

2. Piping accessories.

3. Flexible pipe connectors.

4. Expansion joints and compensators.

5. Pipe loops, offsets, alignment guides and swivel joints.

6. Hydronic Specialties:

   a. Expansion tanks.
   b. Air vents.
   c. Air separators.
   d. Strainers.
   e. Flow indicators, controls, meters.
   f. Brazed plate heat exchangers.
   g. Flushing agents.
   h. Water treatment chemicals.
   i. Glycol specialties.

B. Related Sections:

1. 019100 - Commissioning

2. 200000 - Mechanical General Requirements

3. 200529 - Mechanical Hangers and Supports

4. 200548 - Mechanical Vibration and Seismic Control

5. 200553 - Mechanical Identification

6. 200556 - Interior Trench Excavation and Backfill

7. 200700 - Mechanical Insulation

8. 230593 - Testing, Adjusting and Balancing
9. 232123 - Hydronic Pumps
10. 233600 - Air Terminal Units
11. 235223 - Cast Iron Boilers and Accessories
12. 236400 - Packaged Water Chillers
13. 237323 - Central Air Handling Units
14. 238200 - Terminal Heating and Cooling Units
15. 238316 - Radiant Floor Heating Equipment
16. 253000 - Building Automation System Field Devices
17. 255000 - Building Automation System
18. 259000 - Sequence of Operations

1.2 REFERENCES

A. Codes and Standards:

1. International Mechanical Code (IMC).
2. Uniform Plumbing Code (UPC).
3. NFPA 31 - Installation of Oil-Burning Equipment.
4. ASME Boilers and Pressure Vessel Code (1998), Sections IV & VI.
5. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers.

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.
2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.
3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. This section describes specific requirements, products, and methods of execution for the system of liquid heat transfer throughout the project. The system of heat generation is specified elsewhere.

2. Design expansion compensation system to adequately protect piping and structure from thermal expansion and contraction forces.

B. Performance Requirements:

1. Provide performance and output shown or scheduled on drawings.

2. Provide loops, pipe offsets, and swing joints, or expansion joints where required or indicated.

3. Pipes shall be capable of thermal expansion movement without disengagement of supports or forces on equipment connections.

4. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.

5. Expansion Calculations:

a. Installation Temperature: 40 degrees F.
b. Hot Water Heating: 210 degrees F.
c. Domestic Hot Water: 140 degrees F.
d. Safety Factor: 30 percent.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate installation of hydronic systems and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any hydronic components.

1.5 SUBMITTALS

A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.

2. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

3. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

4. Submit selection calculations for expansion joints and compensators.

5. Design Data: Submit calculations for performance specified products and systems.

C. Shop Drawings:

1. Submit shop drawings for performance-specified products and systems.

2. Submit shop drawings for piping systems to demonstrate proper layout and coordination.

3. Provide shop drawings to show system layout with location and detail of flexible pipe connectors and expansion joints.

4. Drawings of boiler room, fan rooms, and other areas with high-density piping, shall be shown at 1/4-inch scale or larger.

5. Indicate elevation of piping above finish floor.

6. Indicate dimensions and weights of equipment, and placement of openings and holes.

7. Include reference to ductwork and other equipment where space coordination is necessary to avoid conflicts.

8. Indicate mechanical and electrical service locations and requirements.

D. Manufacturer Reports:

1. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:

   a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment. Annotate the manual to indicate applicable information for the specific equipment model(s) installed.
   b. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
      1). Printed names and signatures of the installers.
      2). Documentation from Manufacturer's representative and Contracting Agency that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.

2. Test reports:

   a. Provide certificate that cleaning of hydronic systems has been accomplished.
   b. Provide certificate listing satisfactory results for the hydrostatic pressure tests.

c. Provide certificate listing satisfactory results for the operational tests.

3. Submit a letter to document that the training was conducted. Include in the letter the date, start/stop times for the training, list of attendees and signature/title of the person(s) providing the training.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance (IO&M) Manuals:

1. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.

2. Include the following:

a. Copies of approved submittal information.
b. Manufacturer's installation, operating and maintenance/repair instructions, parts listings, and spare parts list for each product. Annotate the manual to indicate applicable information for the specific equipment model(s) installed.
c. Computer software manuals and applicable licenses.
d. Completed start-up and operational test report as required to validate equipment warranty.
e. Start-up and operational test reports for each piece of equipment. Report shall include printed names and signatures of the installers and documentation that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.

C. Record Documentation: Record actual locations of equipment, valves, strainers, air vents, flexible pipe connectors, expansion joints, other components, and locations of access doors required for maintenance access in accordance with Section 200000 - Mechanical General Requirements.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years documented experience.

2. Installers: Minimum 3 years' experience in the installation and start-up of hydronic systems and equipment.

3. Testing Agencies: Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and as indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

3. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

B. Storage and Protection:

1. Store products outside the general construction zone in covered storage area protected from the elements, until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.9 WARRANTY

A. Manufacturer Warranty:

1. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

2. Provide 1-year manufacturer's warranty.

3. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.

4. Provide to the Contracting Agency 1 copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Water Systems:

1. Copper pipe three inches and smaller:

a. Type L copper, wrought copper fittings.
b. Fit joints using 430 silver solder, 95-5 tin-antimony or other approved lead-free solder. Solder type must be compatible with pipe and fittings. Solder containing lead shall not be allowed on the job site.

c. Soldering flux: Water flushable, low corrosivity type meeting the requirements of ASTM B813. Flux shall have label indicating it meets these requirements.
d. Extracted branch joints (T-Drill) may be approved when Contractor can demonstrate satisfactory experience with this method. Joints shall be brazed in accordance with the Copper Development Association Copper Tube Handbook using B-Cup series filler metal.

2. Steel pipe four inches and larger: Welded pipe and fittings.

a. Grade B, seamless, ASTM A53 or A106.
b. Schedule 40 black with ANSI B16 butt weld fittings of type and wall thickness to suit pipe.

3. Galvanized piping is not permitted.

B. Glycol Systems (Copper or Steel Option):

1. Copper pipe three inches and smaller:

a. Type L copper, wrought copper fittings.
b. Fit joints using 430 silver solder, 95-5 tin-antimony or other approved lead-free solder. Solder type must be compatible with pipe and fittings. Solder containing lead shall not be allowed on the job site.
c. Soldering flux: Water flushable, low corrosivity type meeting the requirements of ASTM B813. Flux shall have label indicating it meets these requirements.
d. Extracted branch joints (T-Drill) may be approved when Contractor can demonstrate satisfactory experience with this method. All joints shall be brazed in accordance with the Copper Development Association Copper Tube Handbook using B-Cup series filler metal.

2. Steel pipe four inches and larger: Welded pipe and fittings. No threaded pipe allowed.

a. Grade B, seamless, ASTM A53 or A106.
b. Schedule 40 black with ANSI B16 butt weld fittings of type and wall thickness to suit pipe.

3. Victaulic mechanical joint-type pipe systems are not permitted.

4. Galvanized piping is not permitted.

C. Copper Press Fitting System (Water or Glycol):

1. Limited to tubing sizes 4 inch and smaller.

2. Cast or wrought copper fittings, ASME B16.18 or ASME B16.22. Pre-formed grooves with pre-lubricated EPDM O-rings designed to seal fitting to copper tubing water tight with the use of manufacturer’s crimping tool. Fittings shall be rated for 250 Degrees F., and 200 psi.

3. IAPMO UPC listing.

4. Manufacturer: Viega ProPress, NIBCO Press System, no substitutions.

D. Equipment drains and overflows: Type L copper pipe, wrought copper fittings.

2.2 VALVES

A. Select valves of the best quality and type suited for the specific service and piping system used. Minimum working pressure rating 125 psig saturated steam or 200 psig W.O.G. Packing material or seals shall not contain asbestos.

B. Manufacturers: Crane, Nibco, Hammond, Jenkins, Grinnell, Milwaukee, Stockham.

C. Ball Valves 2 inch and smaller: Two piece type, full port, bronze body and silicone bronze ball or chrome plated brass ball, TFE seats, blowout proof stem, 150 psig pressure/temperature rating (steam).

A. Ball Valves 2-1/2 inches through 4 inch: Two piece type, full port, bronze body and silicone bronze ball or chrome plated brass ball, TFE seats, 150 psig pressure/temperature rating (steam). May be substituted for gate valves except where otherwise indicated.

B. Ball Valves, 2-1/2 inch through 12 inch: Two piece type, full port, carbon steel or stainless steel body and ball, TFE seats, 150 psig pressure/temperature rating (steam). May be substituted for gate valves except where otherwise indicated.

C. Gate Valves, two inch and smaller: Bronze body and trim, rising stem, solid wedge. Use only where shown on drawings.

D. Gate Valves, 2-1/2 inch through four inch: Iron-body, bronze trim, flanged threaded or sweat fitting. Non-rising stem: Inside screw. Rising stem: OS&Y. Bronze valves optional for 2-1/2 inch and three-inch.

E. Globe Valve two inch and smaller: Bronze body, renewable disc suitable for service.

F. Globe or Angle Valve 2-1/2 inch and larger: Iron body, bronze trim, flanged, bronze disc. Bronze valves optional for 2-1/2 inch and three-inch.

G. Swing Check Valves two inch and smaller: Bronze body, horizontal swing, Y-pattern, Buna-N-disc for water, oil and gas. TFE disc for steam.

H. Swing Check Valves 2-1/2 inch and larger: Iron body, horizontal swing, bolted bonnet, renewable bronze seat and disc, flanged or grooved. Bronze valves optional for 2-1/2 inch and three-inch.

I. Drain Valves: Full port ball valve with threaded hose adapter with bronze end cap. Do not use sillcocks or butterfly valves as drain valves.

J. Valves Specified Elsewhere: Provide special valves such as motor-operated valves, relief valves, temperature regulating valves, etc., as specified under the individual system or as indicated on the drawings.

2.3 UNIONS (STANDARD)

A. Steel Piping (Threaded):

1. Class 150 malleable iron, ground joint, copper or copper alloy seat. Grinnell No. 463. (150 psig steam, 300 wog).

2. Where indicated: Class 250 malleable iron ground joint, copper or copper alloy seat. Grinnell No. 554.

B. Copper Piping (Sweat and Threaded): Cast brass, ground joint, copper to copper, or copper to threaded joint. Grinnell No. 9730 - 9739.

2.4 DIELECTRIC ISOLATORS (ELECTRICALLY INSULATING)

A. Provide dielectric unions for two inch pipe and smaller.

B. Provide dielectric flanges for 2-1/2 inch pipe and larger.

C. Insulating gaskets shall be suitable for fluid type, temperature and pressure.

D. Galvanized pipe to copper: Brass threaded end and sweat copper end.

E. Black steel to copper: Zinc plated steel threaded end and sweat copper end.

F. Manufacturers: Capitol, Epco, Control Plastics, Watts, or approved equal.

2.5 PRESSURE GAUGES

A. Provide where shown on drawings, specified in Part 3, or as required.

B. Bourdon tube type with 4-1/2-inch dial (minimum) accuracy plus or minus one-percent span, recalibratable. Normal operating pressure near midpoint of range. Industrial quality.

C. Gauge cock on gauges and pulsation damper (snubber).

D. Differential pressure gauges shall be piston or diaphragm type with range suitable for application and static pressure capability suitable for system pressure. Orange Research.

2.6 THERMOMETERS

A. Provide where shown on drawings, specified in Part 3, or as required.

B. Liquid in glass type: Industrial quality blue-reading with nine-inch scale length (minimum). Straight angle or adjustable as necessary for visibility.

C. Dial Type: Industrial quality three-inch dial with a 270 degrees (minimum) scale. Straight, angle or remote as necessary for visibility.

D. Normal operating temperature at scale midpoint and sufficient range to cover operating conditions.

E. Provide separable wells of suitable material for piping and mounting hardware for ducts. Set probe in heat transfer paste recommended by thermometer manufacturer.

F. Manufacturers: Trerice, Marsh, Weksler, or approved equal.

2.7 PRESSURE AND TEMPERATURE TEST PLUGS

A. Provide where shown on drawings, specified in Part 3 or as required.

B. Standard type for 1/8-inch diameter pressure or temperature probes. Self seal when probe removed and complete with threaded cap. Minimum continuous rating 125 PSIG and 220 degrees F coincident. Sealing element suitable for fluid in pipe.

C. Provide one thermometer and one pressure gauge for each range required by system parameters.

D. Manufacturers: Sisco, Peterson Equipment, or approved equal.

2.8 FLEXIBLE PIPE CONNECTORS

A. General:

1. System Application: Hot water heating (heating) or 40 percent propylene glycol solution (cooling).

2. System Maximum Operating Temperature: 210 degrees F.

3. Pressure: Internal.

4. Installation: Straight or Offset as shown.

5. Movement: Constant or Intermittent.

6. Maximum offset: Not to exceed 25 percent of the centerline bend radius.

7. Determine appropriate minimum “live hose length” (flexible portion of assembly) based on the centerline bend radius for each application in accordance with manufacturer’s sizing tables.

B. Copper Pipe Flexible Connectors - Small Diameter (Sweat):

1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).

2. Pipe Ends: Copper tube sweat.

3. Corrugated Hose: Bronze.

4. Outer Braid: Single braided bronze.

5. Minimum Working Pressure Rating: 120 PSIG at 250 degrees F.

6. Maximum Temperature Rating: 250 degrees F.

C. Copper Pipe Flexible Connectors - Small Diameter (Removable):

1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).

2. Pipe Ends: Female pipe coupling, Female union, Male Hex Nipple, Male Pipe with Hex Nut.

3. Corrugated Hose: Bronze.

4. Outer Braid: Single braided bronze.

5. Minimum Working Pressure Rating: 120 PSIG at 250 degrees F.

6. Maximum Temperature Rating: 250 degrees F.

D. Steel Pipe Flexible Connectors - Small Diameter (welded):

1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).

2. Pipe Ends: Weld nipple.

3. Corrugated Hose: Bronze.

4. Outer Braid: Single braided bronze.

5. Minimum Working Pressure Rating: 300 PSIG at 250 degrees F.

6. Maximum Temperature Rating: 250 degrees F.

E. Steel Pipe Flexible Connectors - Small Diameter (Removable):

1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).

2. Pipe Ends: Schedule 40 steel with male pipe thread (MPT).

3. Corrugated Hose: Bronze.

4. Outer Braid: Single braided bronze.

5. Minimum Working Pressure Rating: 300 PSIG at 250 degrees F.

6. Maximum Temperature Rating: 250 degrees F.

F. Steel Pipe Flexible Connectors - Large Diameter:

1. Size: 3 inch through 10 inch nominal pipe size (NPS).

2. Pipe Ends: 150 LB plate steel flat faced flange.

3. Corrugated Hose: Type 304 stainless steel.

4. Outer Braid: Single braided Type 304 stainless steel.

5. Minimum Working Pressure Rating: 150 PSIG at 250 degrees F.

6. Maximum Temperature Rating: 250 degrees F.

G. Manufacturers: Metraflex, Keflex, or equal.

2.9 FLEXIBLE EXPANSION LOOP

A. Provide flexible expansion loops of size and type noted on drawings.

B. Flexible loops shall consist of two flexible sections of hose and braid, two 90 degree elbows, and a 180 degree return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Loops shall have a factory supplied, center support nut located at the bottom of the 180 degree return, and a drain/air release plug. They shall impart no thrust loads to system support anchors or building structure.

C. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings.

D. Manufacturer: Metraflex Metraloop or equal.

2.10 ACCESSORIES

A. Pipe Alignment Guides:

1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum one inch thick insulation, minimum three inches travel.

2. Manufacturers: Metraflex or approved equal.

2.11 EXPANSION TANKS

A. General:

1. Performance as scheduled.

2. Partial acceptance flexible heavy duty butyl diaphragm sealed into tank, as scheduled.

B. Construction:

1. Designed, tested and stamped in accordance with ASME SEC 8-D standards; supplied with National Board Form U-1.

2. Welded steel shell and base.

3. Forged steel system connections.

4. Steel support stand.

C. Ratings:

1. Working pressure: 125 PSIG.

2. Working Temperature: 240 degrees F.

3. Precharge: As Scheduled.

D. Accessories:

1. Pressure gage.

2. Air charging fitting.

3. Tank drain isolation valve.

4. System connection isolation valve.

E. Model and size: As scheduled.

F. Manufacturers: Amtrol, Armstrong, Bell & Gossett, Taco, or equal.

2.12 AIR VENTS

A. Coin operated vent: Manual low profile vent for use in baseboard and other enclosures where automatic vent will not fit. 150 PSIG working pressure, 212 degrees F. operating temperature. Bell & Gossett No. 4V or approved equal.

B. Float Type:

1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2. Iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

3. Operating pressure 75 psig, hydrostatic pressure 200 PSI maximum, intended for use in hot or cold lines. Provide ball type isolation valves for air vents that do not have integral shut off valves.

4. Manufacturers: Honeywell EA791004, Hoffman No. 79, or equal.

C. Disc Type:

1. Designed to be replaced without removal from line, with built-in check valve.

2. Limited to baseboard, unit ventilators, cabinet unit heaters, convectors, and elsewhere where air vent must be installed in a cabinet or enclosure, unless other type detailed on drawings.

3. Maximum working pressure: 50 PSIG.

4. Manufacturer: Hoffman No. 500, or equal.

2.13 AIR & DIRT SEPARATORS

A. Construction:

1. Designed, tested and stamped in accordance with ASME standards.

2. Welded steel shell with flanged connections.

3. Entering velocity not to exceed 4 feet per second.

4. Internal copper wound coalescing eliminator.

5. Top venting chamber with integral full port float actuated brass venting mechanism.

6. Side tap with valve to flush dirt or liquids and quick air bleed.

B. Ratings:

1. Working pressure: 150 PSIG (minimum).

2. Working Temperature: 125 degrees F (minimum).

3. Capable of removing 100 percent of free air, 100 percent of entrained air, and 99.6 percent of dissolved air in the system fluid.

4. Dirt separation of at least 80 percent of all particles larger than 30 micron and larger within 100 passes.

C. Size: As scheduled.

D. Manufacturer: Spirotherm VDT (Basis of Design), B&G CRS, Wessels.

2.14 STRAINERS

A. Size two inch and under:

1. Screwed brass or iron body for 175 PSIG working pressure.

2. Y pattern with 1/32-inch stainless steel perforated screen.

B. Size 2-1/2 inches to four inches:

1. Flanged or grooved iron body for 175 PSIG working pressure.

2. Y pattern with 3/64-inch stainless steel perforated screen.

C. Manufacturers: Metraflex, Armstrong, Crane, Hayward, Watts Regulator, Hoffman, Sarco.

2.15 AUTOMATIC FLOW LIMITING AND ISOLATION VALVES

A. Supply pipe side: Brass alloy body with stainless steel flow cartridge assembly, integral ball valve, 20 mesh strainer element, two pressure/temperature test valves and drain valve with hose bibb adapter and end cap. Body design allows removal of flow cartridge without disturbing piping connections. Threaded sweat adapter inlet. Union with sweat adapter outlet.

B. Return pipe side: Forged brass body with integral ball valve, pressure/temperature test valve and manual air vent. Union with sweat adapter inlet. Threaded sweat adapter outlet.

C. Calibration: Control flow within five percent of selected rating, over operating pressure range of at least 10 times minimum pressure required for control. Provide three operating pressure ranges with a minimum range requiring less than 3.5 PSID to actuate flow control cartridge.

D. Flow Control Cartridge: Stainless steel one piece cartridge with segmented port design and full travel linear coil spring.

E. Provide supply and return components packaged as a system and labeled in accordance with the equipment schedule tag to match terminal heating unit served.

F. Manufacturer: Griswold Controls, Bell & Gossett, or approved equal.

2.16 BALANCING VALVES

A. Provide calibrated plug or ball valve type balancing valves with self-sealing quick connect pressure taps, scale and locking device. Include schedule with submittal.

B. Manufacturers: Bell & Gossett, Taco, or equal.

2.17 BRAZED PLATE HEAT EXCHANGERS

A. Provide brazed plate type heat exchanger(s) with the heat transfer and hydraulic performance characteristics as scheduled.

B. Heat exchangers to include the following:

1. Cover plates: Stainless steel ASTM 316L.

2. Channel Plates: Corrugated stainless steel ASTM 316L, vacuum brazed together.

3. Brazing material: Copper.

4. Connections: Stainless steel ASTM 316L.

5. Design pressure: 435 PSIG.

6. Design temperature: -310 degrees F (minimum) and 450 degrees F (maximum).

C. Manufacturers: Bell & Gossett, Trantor, or equal.

2.18 FLUSHING AGENT

A. Synthetic organic dispersant manufacturer: CH2O, Product 6149 or approved equal.

2.19 WATER TREATMENT

A. Hydronic loop treatment manufacturer: CH2O, Product 6439 or approved equal.

2.20 GLYCOL SYSTEMS

A. Provide equipment and products specifically designed and approved for continuous operation with the glycol solution specified.

B. Glycol Solution:

1. Inhibited propylene glycol solution premixed to 40 percent by volume for use with hydronic heating and cooling systems.

2. Fluid analysis test kit.

3. Manufacturer: Dow Chemical Company Dowfrost. No substitutes.

C. Automatic Glycol Make-up System:

1. Provide packaged glycol make-up system as scheduled with single point electrical connection.

2. Fill glycol make-up tank one half full with clean solution after testing and final system check out has been completed.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in hydronic system construction and under the supervision of a qualified installation supervisor.

3.2 PREPARATION

A. Protection of In-Place Conditions: Cover equipment and plug piping connections to protect components from construction dirt and debris.

B. Surface Preparation:

1. Prior to installation of equipment, verify concrete housekeeping pads are complete and properly sized for equipment mounting.

2. Prior to installation of piping and equipment, verify that shop drawings are approved and locations and routing have been coordinated with the work of other trades.

3.3 INSTALLATION

A. Special Techniques:

1. Install equipment in accordance with manufacturer's instructions and requirements of the codes specified herein.

2. Provide finished products with protective covers during balance of construction.

3. Provide accessible ball type isolation valves at major piping branches, and on main lines as shown, and at terminal devices. Provide drains and manual vents at main line and branch line valves to facilitate draining and filling piping sections. Provide caps on drain outlets.

4. Access Doors: Provide appropriate size and install such that hydronic system features are readily accessible and maintainable.

5. Install balancing valves and automatic flow limiting valves to be accessible and adjustable.

6. Install piping to maintain headroom, conserve space, and not interfere with use of space.

7. Use of bullhead tee with opposed flow, double inlet configuration not allowed.

8. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

9. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

10. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Division 09 - Finishes.

11. Thermal Expansion:

a. Install piping to allow for normal thermal expansion and contraction without stressing pipe, joints, or connected equipment.
b. Provide anchors where necessary and as shown.
c. Provide support and expansion loops, expansion compensators, and alignment guides to suit conditions and as shown on drawings.

d. Piping shall be guided and restrained as recommended by the manufacturer.

12. Provide test plugs on both inlet and outlet sides of heat transfer elements to allow measurement of both fluid pressure drop and differential temperature.

13. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

14. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

15. Provide pipe anchors offsets, loops and expansion compensators as required to control the expansion of pipelines.

16. Flushing:

a. Clean internal surfaces of the completed heating system as follows:
1). Flush hydronic piping to remove black magnetic iron oxide and mill scale from the system.
2). Flush system piping with synthetic organic dispersant to remove grease. Circulate solution through system at 150 degrees F. or greater for 12 to 24 hours.
3). Repeat process until the system is clean to the satisfaction of the Contracting Agency.
4). Flush system with fresh water as necessary to remove residual cleaning agent.
5). Exercise proper care during flushing and cleaning of systems to make sure no damage is done to equipment, valves, fittings, or Work of other trades. Restore damaged system components or Work of other trades to new or original condition at no additional cost to Owner.

B. Interface with Other Work: Coordinate and sequence installation of hydronic products with trades responsible for portions of this and other related sections of the Project Manual.

3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

C. Touch-up finished surfaces with touch-up paint provided by the equipment manufacturer.

3.5 SITE QUALITY CONTROL

A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer’s written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

B. Manufacturer Services:

1. Verify units are installed and operational in accordance with the manufacturer's written installation instructions.

2. Both the Contractor and Manufacturer's Representative(s) shall sign start-up and operational checklist to confirm proper unit installation and operation.

3. Provide samples of the inhibited propylene glycol solution to the manufacturer for testing using the fluid analysis test kit provided.

4. The manufacturer of the inhibited propylene glycol solution shall provide free testing of the solution 24 hours after system startup and again 90 days later to verify proper fluid performance for both tests.

5. Provide one copy of manufacturer's test reports to the Owner. Adjust fluid concentration and/or correct deficiencies as addressed in the report.

C. Hydronic System Cleaning and Treatment Coordination Meeting:

1. Conduct a meeting prior to flush cleaning and treatment of the hydronic heating system to discuss cleaning agents, treatment chemicals and procedures to be used. Discuss system fill procedures with inhibited propylene glycol solution.

2. Participants shall include the Contractor, Subcontractor directly performing the work and the Owner's Maintenance Staff personnel.

3. Provide one week notice prior to the meeting.

4. Cleaning, filling and treatment of the hydronic heating system is not permitted until this coordination meeting has been conducted and the Contracting Agency's concerns have been adequately addressed.

D. System fill:

1. After flush cleaning the hydronic heating system, fill the primary system with water and add treatment chemicals to the concentration recommended by the manufacturer. Fill the secondary loop system with inhibited propylene glycol solution as specified.

2. Thoroughly vent the systems to include piping high points and equipment vents (pump casings, air separators, etc.).

E. Site Tests:

1. Hydrostatic Pressure Test:

a. Make sure hydronic heating system is filled with clean operating fluid. Hydrostatically test system to 100 PSIG. System must hold test pressure for a two hour period with no pressure drop to pass test.
b. Inspect system during test and repair leaks.

c. Provide written report indicating that the pressure test has been satisfactorily completed.

2. Operational Test:

a. Inspect system for proper fluid circulation, sufficient clearance for expansion and contraction of piping and proper system pressure control.
b. Note and correct discrepancies and deficiencies.
c. Provide written report indicating that the operational test has been satisfactorily completed.

3. Test results shall be certified in writing as required by General Conditions. Include dates and sections tested, test pressure, test duration, printed names and signatures of person performing the test and Contracting Agency witnessing the test.

F. Inspection: Arrange for inspections and provide notice to the Contracting Agency when the entire work or logical portions thereof, is ready for inspection.

G. Verify penetrations are installed to maintain assembly integrity.

3.6 SYSTEM STARTUP

A. Start-up and operate hydronic heating systems and equipment in accordance with the manufacturer’s written installation and operation manual checklist.

B. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

3.7 ADJUSTING

A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.

B. Coordinate and work directly with the Balancing and Testing Agency and the requirements of Section 230593 - Testing, Adjusting and Balancing, to provide systems in proper operating order.

C. Make corrections and adjustments as required by the Testing, Adjusting and Balancing (TAB) Agency in a timely manner.

3.8 CLEANING

A. Waste Management: After construction is completed, clean and wipe down exposed surfaces of pumps, piping and appurtenances.

3.9 CLOSEOUT ACTIVITIES

A. Demonstration: Provide 2 hours of demonstration conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

B. Training: Provide 4 hours of operational instruction conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

END OF SECTION 232113

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. System lubricated circulators.
2. In-line circulators.
3. Vertical in-line pumps.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200529 - Mechanical Hangers and Supports
5. 200548 - Mechanical Vibration and Seismic Control
6. 200553 - Mechanical Identification
7. 230593 - Testing, Adjusting and Balancing
8. 232113 - Hydronic Piping and Specialties
9. 235223 - Cast Iron Boilers and Accessories
10. 236400 - Packaged Water Chillers
11. 238316 - Radiant Floor Heating Equipment
12. 253000 - Building Automation System Field Devices
13. 254000 - Variable Speed Drives
14. 255000 - Building Automation System
15. 259000 - Sequence of Operations

1.2 REFERENCES

A. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. This section describes specific requirements, products and methods of execution for interrelated systems necessary for the pumping of heating fluid, which will be distributed to the locations shown.

2. The method of generation of, and distribution of, this heat is specified elsewhere.

B. Performance Requirements:

1. Select pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

2. Provide performance and output shown or scheduled on drawings.

1.4 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements.

B. Product Data:

1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria.

2. Include the following:

a. Catalog data sheets for each pump scheduled. Indicate which model is being submitted.
b. Certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
c. Dimensional data.
d. Features and appurtenances being provided.
e. Electrical characteristics and connection requirements.

C. Shop Drawings:

1. Submit fully dimensioned shop drawings of boiler room showing major equipment and housekeeping pads, with clear callouts indicating deviations from layout shown.

2. Indicate mechanical and electrical service locations and requirements.

D. Quality Assurance/Control Submittals:

1. Design Data and Test Reports: Provide design data and test reports for each pump.

2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:

   a. Provide a complete manufacturer's written installation, operation and maintenance manual for each installed pump. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
   b. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
      1). Printed names and signatures of the installers.
      2). Documentation from Manufacturer's representative and Contracting Agency that the pumps have been properly installed and is fully operational, thus validating the equipment warranty.

E. Closeout Submittals:

1. Project Record Documents: Record actual locations of pumps and associated valves, and areas required for maintenance access.

2. Operation and Maintenance (IO&M) Manuals:

   a. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
   b. Provide copies of approved submittal information for inclusion within the project IO&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, assembly views, lubrication instructions, maintenance and repair data, parts listings, and spare parts list.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

2. Acceptable Installers: Minimum three years experience in the installation and start-up of pumps.

B. Pre-Installation Meetings: Coordinate installation of pumps and associated piping and valves with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

C. Regulatory Requirements: Products Requiring Electrical Connection - Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion:

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Protection:

1. Outside the general construction zone, store products in covered storage area protected from the elements until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.7 WARRANTY

A. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

B. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.

C. Provide to the Contracting Agency one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

PART 2 - PRODUCTS

2.1 SYSTEM LUBRICATED CIRCULATORS

A. Type: Horizontal shaft, single-stage, direct connected, with resiliently mounted motor for in-line mounting.

B. Materials:

1. Pump: Cast iron, with flanged pump connections.

2. Impeller: Non-metallic.

3. Mechanical Seal Assembly: None.

C. Performance:

1. As scheduled.

2. Maximum working temperature: 230 degrees F.

3. Maximum working pressure: 200 PSIG.

D. Electrical Characteristics:

1. As scheduled.

2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

E. Manufacturers: Taco 00 or Loadmatch Series (Basis of Design), Armstrong, Bell and Gossett, Grundfos.

2.2 IN-LINE CIRCULATORS

A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting.

B. Materials:

1. Pump Volute: Cast iron, with 125 PSIG ANSI flanged pump connections.

2. Impeller: Stainless Steel.

3. Shaft: Alloy steel copper sleeve.

4. Mechanical Seal Assembly: Carbon brass trim, ceramic seat.

C. Performance:

1. As scheduled.

2. Maximum working temperature: 230 degrees F.

3. Maximum working pressure: 145 PSIG.

D. Electrical Characteristics:

1. As scheduled.

2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

E. Manufacturers: Taco (Basis of Design), Armstrong, Bell and Gossett, Grundfos.

2.3 VERTICAL IN-LINE PUMPS

A. Type: Single stage, single suction, split coupled, vertical in-line pump with inverter duty motor for VSD operation.

B. Materials:

1. Pump Body: Cast iron, with 125 PSIG ANSI flanged connections.

2. Impeller: Stainless Steel.

3. Bearings: Sleeve, Oil Lubricated.

4. Shafts: Stainless steel.

5. Mechanical Seal Assembly:

a. Stationary face: Carbon.
b. Rotating face: Tungsten Carbide.

C. Performance:

1. As scheduled.

2. Maximum working temperature: 250 degrees F.

3. Maximum working pressure: 175 PSIG.

D. Electrical Characteristics:

1. As scheduled.

2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

E. Manufacturers: Taco (Basis of Design), Armstrong, Bell and Gossett, Grundfos.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection: Cover pumps and plug piping connections to protect pumps from construction dirt and debris.

B. Preparation: Prior to installation of pumps, verify that electrical power is available and of the same voltage and phase characteristics as the pump being installed.

3.2 INSTALLATION

A. Install pumps, pump supports, suction guides, mechanical seal piping, pressure gauges and other pump appurtenances in accordance with the manufacturer's written installation instructions.

B. Provide access space around pumps for service. Provide no less than the minimum as recommended by manufacturer.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings.

D. Provide line sized shut-off valve on pump suction, and line sized soft seat check valve.

E. Provide air cock and drain connection on horizontal pump casings.

F. Provide drains for bases and seals, piped to and discharging into floor drains.

G. Provide gauges with connections to suction and discharge.

H. Install close coupled and base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place.

I. Lubricate pumps before start-up.

3.3 CONSTRUCTION

A. Interface with Other Work:

1. Coordinate and sequence installation of pumps and appurtenances with trades responsible for portions of this and other related sections of the Project Manual.

2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. After completion of the installation, a qualified representative of the pump manufacturer shall conduct pump start-up and written certification.

2. Start-up and adjust the system to within the tolerances as specified by the equipment manufacturer. Verify pump impellers rotate in the correct direction.

3. Provide two hours operating instruction to authorized Owner's Representative.

4. Test pump operation and sequencing in accordance with the manufacturer's written installation and testing instructions and Section 259000 - Sequence of Operations.

5. Submit a letter of certification indicating that the pump installation and start-up has been completed, that the pumps are properly adjusted and operating within the tolerances as specified by the manufacturer, and that the sequence of operation is fulfilled.

3.6 ADJUSTING

A. Coordinate and work directly with the Testing, Adjusting and Balancing Agency to provide systems in proper operating order. Make corrections and adjustments as required by the Testing, Adjusting and Balancing Agency in a timely manner.

3.7 CLEANING

A. After construction is completed, clean and wipe down exposed surfaces of pumps, piping and appurtenances.

B. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.

3.8 DEMONSTRATION & START-UP

A. Start-up and operate hydronic pumps in accordance with the manufacturer’s written installation and operation manual checklist.

B. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

END OF SECTION 232123

SECTION 233100 - DUCTS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal Ductwork and Fittings.
2. Flexible Ductwork.
3. Volume Dampers.
4. Control Dampers.
5. Fire Dampers.
6. Duct silencers.
7. Flexible Duct Connectors.
8. Access Panels and Doors.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200529 - Mechanical Hangers and Supports
4. 200548 - Mechanical Vibration and Seismic Control
5. 200700 - Mechanical Insulation
6. 230131 - Duct Cleaning
7. 230593 - Testing, Adjusting and Balancing
8. 233400 - HVAC Fans
9. 233600 - Air Terminal Units
10. 233700 - Air Outlets and Inlets
11. Division - Electrical

1.2 REFERENCES

A. Codes and Standards:

1. International Building Code (IBC).

2. International Mechanical Code (IMC).

3. ASHRAE Standard 90.1-2010 Energy Standard for Buildings Except Low-Rise Residential Buildings.

4. SMACNA HVAC Duct Construction Standards - Metal and Flexible, Third Edition 2005.

5. SMACNA HVAC Air Duct Leakage Test Manual, Second Edition 2012.

6. SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, Fifth Edition 2002.

7. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.

8. ACR the National Air Duct Cleaners Association (NADCA) Standard for Assessment, Cleaning and Restoration of HVAC Systems, 2013.

1.3 PREINSTALLATION MEETINGS

A. Coordinate installation of ductwork and accessories with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of ductwork and accessories.

1.4 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data: Include manufacturer’s detailed fire damper installation instructions for each specific wall, ceiling, and floor construction type(s) for the project.

C. Shop Drawings:

1. Include the following information in the scaled ventilation system shop drawings:

a. Label duct sizes using the same labeling method as the Contract Documents.
b. Show terminal equipment ductwork connections.
c. Volume, control, backdraft, and fire damper locations as applicable.
d. Flexible connection locations.
e. Access panels and doors with sizes and swing directions shown.

2. Casings and plenums: Submit detailed shop drawings showing the proposed plenum and casing materials to be used and the construction method.

D. Installation, Operation and Maintenance (IO&M) Manuals.

1.5 CLOSEOUT SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.

C. Record Documentation: Record actual locations of ductwork and areas required for maintenance access in accordance with Section 200000 - Mechanical General Requirements.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Minimum five years of documented experience manufacturing commercial HVAC duct work and accessories in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

2. Installers: Minimum five years of experience in the installation of commercial HVAC ductwork and accessories in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 200000 - Mechanical General Requirements for general delivery, storage and handling requirements.

1.8 WARRANTY

A. Refer to Section 200000 - Mechanical General Requirements for general warranty requirements.

PART 2 - PRODUCTS

2.1 METAL DUCTWORK AND FITTINGS

A. General: Provide metal ductwork and fittings fabricated in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, G90 zinc coated unless otherwise noted.

B. Medium Pressure/Velocity Ductwork:

1. Duct Pressure Class: 4 inches WC.

2. Seal Class: A.

3. Maximum Velocity: 2,200 FPM.

C. Low Pressure/Velocity Ductwork:

1. Duct Pressure Class: 2 inches WC.

2. Seal Class: A.

3. Maximum Velocity: 1,500 FPM.

2.2 FLEXIBLE DUCTWORK

A. Manufacturers:

1. Thermaflex, Model M-KE.

2. Hart & Cooley.

3. JPL.

4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Description: UL listed, Class 1 flexible ductwork in compliance with NFPA 90A and 90B.

C. Performance/Design Criteria:

1. Positive Pressure Rating:

Ten inches WC	(4”-12” ID).
Six inches WC	(14”-16” ID).
Four inches WC	(18”-20” ID).

2. Negative Pressure Rating:

One inch WC	(4”-12” ID).
One half inch WC	(14”-20” ID).

3. Maximum Velocity: 5000 FPM.

4. Operating Temperature Range:

a. 0 degrees F to 140 degrees F (continuous).
b. Minus 20 degrees F to 250 degrees F (intermittent).

5. Insulating Value: R-4.2.

D. Materials:

1. Acoustically rated black polyester core permanently bonded to coated spring steel wire helix.

2. Fiberglass insulation.

3. Tear resistant, reinforced metalized vapor barrier.

2.3 VOLUME / BALANCING DAMPERS

A. Manufacturers:

1. Ruskin.

2. Greenheck.

3. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Materials:

1. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for fabricated volume damper construction requirements.

2. Round ducts to 12 inch diameter and rectangular to 18 inch width:

a. Flat sheet, galvanized steel, single blade damper.
b. Damper blade two gauges thicker than the duct gauge at the location installed (24 gauge minimum for round, 22 gauge minimum for rectangular).
c. Manual hand quadrant.

3. Round ducts over 12 inch diameter:

a. Flat sheet, galvanized steel, single blade damper.
b. Damper blade two gauges thicker than the duct gauge at the location installed (22 gauge minimum).
c. Manual hand quadrant with continuous steel rod.

4. Rectangular ducts over 18 inch width:

a. Flat sheet, galvanized steel, single blade damper.
b. Damper blade 18 gauge minimum.
c. Manual hand quadrant with continuous steel rod.

5. Accessible and lockable damper operators.

C. Extractors: Not Permitted.

D. Splitter Dampers: Not Permitted.

2.4 REMOTE VOLUME DAMPER OPERATORS

A. Manufacturers:

1. Duro-dyne.

2. Young Regulator.

3. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Provide flush mounted chrome plated remote operators with tamperproof cover, extension rod, and not more than one 90 degree angle gear drive.

C. Regulator: Duro-dyne Series SRC-380 or Young Regulator 301.

D. Angle Drive: Duro-dyne Model AD-38 or Young Regulator 927.

2.5 CONTROL DAMPERS

A. Manufacturers:

1. Ruskin, Model CD50 (rectangular) or CDR25 (round).

2. Greenheck, Model VCD-43 (rectangular).

3. Air Balance.

4. Pottorff.

5. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Rectangular:

1. Performance/Design Criteria:

a. Temperature Limits: Minus 72 degrees F. to plus 275 degrees F.
b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
   1). Closed Position: Maximum pressure of 13 inches W.C. at a 12-inch blade length.
   2). Open Position: Maximum air velocity of 6,000 feet per minute.

c. Leakage: Maximum 3.0 cubic feet per minute per square foot at 1.0 inch W.C. for sizes 24 inches wide and above.
d. Pressure Drop: Maximum 0.05 inches W.C. at 1,500 feet per minute across 24 inch by 24 inch damper.

2. Material:

a. Frame: Five inches by one inch by minimum 0.125 inch 6063T5 extruded aluminum hat channel, mounting flanges on both sides of frame, reinforced at corners.
b. Blades: Airfoil-shaped, single-piece blades made of heavy-duty 6063T5 extruded aluminum. Maximum 6 inches blade depth.
c. Bearings: Non-corrosive, molded synthetic sleeve, turning in hole in frame.
d. Seals:
   1). Blade: Extruded vinyl type for ultra-low leakage. Mechanically attached to blade edge.
   2). Jamb: Flexible metal compressible.

e. Linkage: Concealed in frame.
f. Axles: Minimum 1/2-inch diameter plated steel hex, mechanically attached to blade.

3. Finishes: Mill aluminum.

C. Round:

1. Performance/Design Criteria:

a. Temperature Rating: Maximum 250 degrees F.
b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
c. Closed Position: Maximum pressure of 10 inches W.C.
d. Maximum system velocity: 4,000 feet per minute.
e. Maximum Leakage: Maximum 6 cubic feet per minute per square foot at 1 inch W.C.
f. Pressure Drop: Maximum 0.05 inch W.C. at air volume of 7,000 cubic feet per minute through 24 inch diameter damper.

2. Material:

a. Frame:
   1). Under 6 inches Diameter: Two inches by minimum 12 gauge galvanized steel tube.
   2). 6 through 12 inches Diameter: Two inches by 1/2 inch by minimum 14 gauge galvanized steel channel.
   3). Above 12 through 24 inches Diameter: Two inches by 1/2 inch by minimum 1/8 inch galvanized steel channel.

b. Blade: Provide single-piece construction made of the following material:
   1). 18 inches diameter and less: Minimum 12 gage galvanized steel.
   2). Over 18 inches diameter: Minimum 10 gage galvanized steel, stiffeners as required.

c. Blade Seals: Closed cell polyethylene foam rubber or neoprene, fully encompassing and mechanically attached to blade edge.
d. Bearings: Self-lubricating stainless steel sleeve.
e. Axles: Minimum 1/2 inch diameter plated steel, full length of and extending 6” beyond damper frame, mechanically attached to blade.

3. Finishes: Mill galvanized.

2.6 FIRE DAMPERS

A. Manufacturers:

1. Ruskin (Basis of Design).

2. Greenheck.

3. Pottorff.

4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Regulatory Requirements:

1. UL listed and labeled in accordance with UL Standard 555.

C. Performance/Design Criteria:

1. Fire rating suitable for the applicable wall construction rating in accordance with IBC.

2. Rated for use in dynamic system with maximum velocity of 2,000 fpm and maximum 4" w.g. static pressure.

3. Provide with 165 degrees F fuse link.

2.7 DUCT SILENCERS

A. Manufacturers:

1. Price (Basis of Design).

2. Vibro-Acoustics.

3. Ruskin.

4. United McGill.

5. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Performance/Design Criteria:

1. Size, configuration, capacity and acoustic performance as scheduled.

2. Factory fabricated and supplied by the same manufacturer.

3. Performance of silencers including dynamic insertion loss, self-noise, and pressure loss shall be determined by the manufacturer's certified laboratory and certified in accordance with ASTM Standard E477.

C. The manufacturer shall supply certified dynamic insertion loss and self-noise power level data for each scheduled silencer. The data shall match the project's air distribution system requirement for forward or reverse flow, and total system airflow. ASTM E-477-06a tests to obtain this data shall be conducted in the same facility and shall utilize the same silencer.

D. Construction:

1. The outer shell shall at least equal SMACNA requirements for the positive or negative static pressure at the point of application. Interior surfaces shall be smooth and streamlined.

2. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in other sections are minimums. Material gauges shall be increased as required for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.

3. Casing seams and joints shall be lock-formed and sealed or stitch welded and sealed to provide leakage-resistant construction.

4. Perforated steel shall be adequately stiffened to insure flatness and form. Spot welds shall be painted.

5. Silencer assemblies including acoustic media shall not have flame-spread index exceeding 25 and smoke-developed index exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.

E. Silencer inlet and outlet connection dimensions shall be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the drawings or pre-approved shop drawings.

F. Circular Silencers; outer casing shall be G90 galvanized sheet steel, gauge as listed below:

1. Sheet metal thickness for units up to 18 inches in diameter: 22 gauge.

2. Sheet metal thickness for units 18 through 30 inches in diameter: 20 gauge.

3. Sheet metal thickness for units 30 through 54 inches in diameter: 18 gauge.

4. Sheet metal thickness for units over 54 inches in diameter: 16 gauge.

G. Inner perforated metal liner shall be G90 galvanized sheet steel, minimum gauge as listed below:

1. Rectangular Silencers: 26 gauge.

2. Rectangular Elbow Silencers: 22 gauge.

3. Circular Silencers:

   a. Connection diameter up to 18 inches: 26 gauge.
   b. Connection diameter greater than 18 inches: 22 gauge.

H. Media Protection:

1. Acoustic media for film lined silencers shall be completely wrapped with polymer film to help prevent shedding, erosion and impregnation.

2. Separate the wrapped acoustic media from the perforated metal by a factory installed acoustically transparent spacer. The spacer shall be flame retardant and erosion resistant. A mesh, screen or corrugated perforated liner will not be acceptable as a substitute for the specified spacer.

I. Silencers shall be shipped with factory-installed end caps to prevent contamination during shipping.

2.8 FLEXIBLE DUCT CONNECTORS

A. Manufacturers:

1. Duro-dyne Corporation.

2. Vent Fabrics.

3. Ductmate.

4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Performance/Design Criteria: Provide fan connectors with static pressure ratings suitable for each specific application. Minimum pressure ratings must be greater than, or equal to, the fan's shut-off static pressure, as indicated by the submitted fan curve, with a fifty (50) percent safety factor.

C. Materials:

1. Metal edging: 24 gauge galvanized steel.

2. Fabric: UL Listed, polyester blend with vinyl coating. Double folded seams. Four (4) inch width.

2.9 ACCESS PANELS AND DOORS FOR DUCTS AND PLENUMS

A. Manufacturers:

1. Air Balance Inc. model FSA-100 (Basis of Design).

2. Ruskin.

3. Ductmate.

4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Material:

1. Frame and Door: Minimum 24 gauge galvanized steel.

2. Reinforced doors with cross-bracing and/or otherwise stiffened to prevent rattling and vibration.

3. Seals: Rubber gaskets, secured to door or frame.

4. Where ductwork is insulated or lined, provide double-walled access door panels with one (1) inch of internal insulation to match duct or plenum insulating and/or sound attenuating characteristics.

5. Walk Through Doors:

a. Construct in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
b. Provide insulation and inner liner to match plenum or casing.

C. Hinges and Latches:

1. Low velocity system access panels:

a. Sizes 12 inches by 12 inches through 24 inches by 24 inches.
b. Continuous steel hinge mechanically fastened to frame and quarter turn cam latches.

2. Medium velocity system access panels:

a. Sizes 12 inches by 12 inches through 24 inches by 24 inches.
b. Continuous steel hinge mechanically fastened to frame.
c. Provide a minimum of two latches for rolled plate doors.
d. Cement sheet rubber gasket to door.

3. Walk through doors (any dimension over 24 inches):

a. Provide three hinges.
b. Provide two latches with inside and outside handles.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify location, size and type (i.e. fire resistive construction) of wall, floor and ceiling/roof penetrations.

3.2 PREPARATION

A. Protection on In-Place Conditions: During construction, install temporary closures of sheet metal, cardboard or polyethylene taped over ductwork openings to prevent construction dust and debris from entering duct systems.

3.3 INSTALLATION

A. Metal Ductwork and Fittings:

1. Install, seal and support ductwork and fittings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible for the duct pressure class and seal class specified. The use of “duct tape” as a duct seal method is prohibited.

2. Provide medium pressure/velocity ductwork at the following locations: VAV ventilation systems from air handler cabinet discharge plenum connection to VAV terminal unit inlet neck connection.

3. Provide low pressure/velocity ductwork at the following locations:

   a. VAV terminal unit discharge connections to air outlet connections.
   b. Outside air intake ductwork.
   c. Exhaust and relief air ductwork.
   d. Constant volume ventilating systems.

4. Proprietary or other joint systems may be substituted for SMACNA details when submitted and approved in writing before starting work.

5. Where ducts penetrate through walls exposed in occupied spaces, provide sheet metal escutcheons at each penetration to provide a clean, finished appearance.

6. Duct penetrations: See Section 200529 – Mechanical Hangers and Supports.

7. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoffs, use 90-degree conical tee or low-loss tee connections.

8. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream of equipment.

9. Provide orifice plates or balance dampers at branch connections as required for proper ventilation system balancing. Select balancing device and installation method to limit noise from mechanical vibration or air bypass.

10. Do not use turning vanes in medium velocity duct systems.

11. Support duct mounted equipment equal to or greater than 40 pounds, such as heating coils, independently from ductwork.

12. Support duct mounted equipment less than 40 pounds using standard duct supports and sway bracing located within 12 inches of equipment.

13. Where offsetting ductwork is not possible, ducts may be reduced a maximum of 20 percent to clear obstacles with Contracting Agency's permission.

14. Where steel ductwork is visible through air outlets or inlets, paint visible interior ductwork flat black.

B. Flexible Ductwork:

1. Install, connect and support flexible ductwork in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

2. Connection to air outlets in suspended grid ceiling systems: Provide a flexible duct length of 8 to 10 feet with one 90-degree bend or large radius 180-degree curve in addition to outlet connection. Support flexible duct at connections to air outlets to maintain minimum recommended bend radius.

3. Seal flexible duct connections to rigid ductwork with draw bands to the pressure class of the rigid duct system.

4. Flexible duct connections between medium pressure ductwork and air terminal units are prohibited.

5. Flexible ductwork is prohibited in inaccessible locations, such as above "hard" ceilings.

6. Flexible ductwork is prohibited at penetrations through walls.

C. Volume Dampers:

1. Provide air volume dampers at each low-pressure duct main and branch take-off for proper air balancing.

2. Locate dampers a minimum of 10 feet from diffusers except where shown otherwise.

3. Volume dampers are not to be installed in medium pressure, variable air volume systems.

D. Control Dampers:

1. Provide opposed blade type dampers for the following applications:

a. Exhaust fan discharge dampers.
b. Outside air intake dampers.
c. Isolation dampers.

2. Provide parallel dampers for the following application: Air handling unit mixing box.

E. Fire Dampers:

1. Before starting work, verify the location and types of fire resistive construction as indicated by the Contract Drawings. Typical fire rated separations include:

a. Area separation walls, vertical only.
b. Occupancy separation walls, or partitions and floors. Vertical or horizontal.
c. Fire resistive egress corridors, halls and vestibules.
d. Fire resistive enclosures of hazardous spaces within an occupancy, including rooms for fuel-fired or electric heating equipment.
e. Fire resistive floor/ceiling assemblies associated with any of the above.

2. Verify locations and types of dampers indicated on drawings. If dampers appear to be incorrectly located or missing, obtain clarification from Contracting Agency.

3. Install dampers at locations indicated on the Drawings and in accordance with manufacturer's UL approved installation instructions.

4. Install round dampers plumb and free from racking. Install rectangular dampers square and free from racking.

5. Do not compress or stretch damper sleeve into duct or opening.

6. Handle damper using frame/sleeve. Do not lift damper using blade, actuator, or jackshaft.

F. Duct Silencers:

1. Locate duct silencers as shown.

2. Install silencers according to manufacturer’s written installation instructions.

3. Modifications to duct connections or fittings within 10 duct diameters upstream or downstream of silencer shall be submitted with duct silencer manufacturer's review and impact of system effects for approval.

G. Flexible Duct Connectors:

1. Install duct connectors in accordance with the manufacturers written installation instructions.

2. Provide a flexible airtight joint between fans and other vibrating equipment and the air distribution ductwork systems.

3. Externally isolated air handling units and fans: Provide flexible connections where ducts attach to unit inlet and outlet(s) of unit.

H. Penetrations:

1. Coordinate mechanical penetrations with architectural and structural construction details prior to installation. Set sleeves in position in concrete formwork. Provide reinforcement around sleeves as required.
2. Provide compatible materials, fasteners, adhesives, sealants, and other products required for proper installation.
3. Penetrations through roof, exterior walls and floors to be weather and water tight.
4. Penetrations through fire rated assemblies to be UL listed.
5. Penetrations through smoke partitions and barriers to resist passage of smoke.

6. Other penetrations to have acoustical seals.

I. Access Panels and Doors:

1. Locate access doors to enable in-duct equipment to be easily inspected, cleaned, maintained and tested and/or reset.

2. Provide access doors at the following locations:

a. Fire dampers.
b. Motor operated dampers.
c. Each side of duct mounted coils.
d. As necessary for duct cleaning in accordance with NADCA Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components.
e. As necessary for maintenance access to serviceable instrumentation and control equipment.

3. Coordinate location and size of access doors in walls, partitions and ceilings to correspond with duct access doors, dampers and automatic control devices and instruments.

4. Coordinate with supplier of component air handlers, package units and similar equipment to ensure that access doors and panels will not be obstructed when the equipment is installed.

J. Interface with Other Work:

1. Assist electrical and controls trades in mounting instrumentation devices and safety controls in ductwork and air handling units.

2. Make penetrations through exterior building walls watertight. Detail ductwork connections to prevent condensation or leakage from entering into surrounding building construction. Provide sleeves, special connections and sealant as required to accomplish this performance requirement.

3.4 SITE QUALITY CONTROL

A. Verify accessibility to ventilation system components for maintenance, adjustment and cleaning.

3.5 ADJUSTING

A. Adjust and balance dampers in accordance with Section 230593 - Testing. Adjusting and Balancing.

3.6 CLEANING

A. Prior to building occupancy and after ventilating systems are complete and functional, verify cleanliness of ventilating system ductwork. Verification shall comply with the inspection method(s) outlined in the National Air Duct Cleaners Association (NADCA) Standard for Assessment, Cleaning, and Restoration of HVAC Systems 2013. Conduct inspection in the presence of a Contracting Agency representative.

B. If the ductwork does not comply with the standard for cleanliness, clean the affected ductwork as follows:

1. Small systems: Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient airflow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.

2. Large systems: Clean duct systems with high power vacuum machines. Protect equipment with potential to be harmed by excessive dirt with filters, or bypass during cleaning.

END OF SECTION 233100

SECTION 233400 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. In-line centrifugal fans.
2. Modular small cabinet fans.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200529 - Mechanical Hangers and Supports
5. 200548 - Mechanical Vibration and Seismic Control
6. 200553 - Mechanical Identification
7. 230593 - Testing, Adjusting and Balancing
8. 233100 - Ducts and Accessories
9. 233700 - Air Outlets and Inlets
10. 253000 - Building Automation System Field Devices
11. 254000 - Variable Speed Drives
12. 255000 - Building Automation System
13. 259000 - Sequence of Operations
14. Divisions 26, 27 and 28 - Electrical

1.2 REFERENCES

A. Codes and Standards:

1. International Mechanical Code (IMC).

2. NFPA 70 - National Electrical Code.

3. Air Movement and Control Association (AMCA) 99 - Standards Handbook.

4. ANSI/AMCA 210 (ANSI/ASHRAE Standard 51) - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

5. AMCA Publication 261 Directory of Products Licensed to Bear the AMCA Certified Rating Seal.

6. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

7. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

8. ASHRAE Handbook 2012 HVAC Systems and Equipment, Chapter 21 - Fans.

1.3 PREINSTALLATION MEETINGS

A. Coordinate installation of fans with trades responsible for portions of this and other related sections of the Project Manual prior to installation of fans.

1.4 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Provide fan curves with scheduled operating point clearly plotted.

2. Provide sound power levels (in decibels) for each octave band for inlet, discharge, and radiated sound power for the assembled fan unit. Obtain sound level data by one of the following methods:

a. Actual measurements from tests performed in accordance with AMCA Standards in an AMCA registered test chamber.
b. Documented calculations that start with AMCA tested fan sound data and are modified in accordance with ASHRAE procedures identified in Chapter 48 of the 2011 ASHRAE HVAC Applications Handbook to accurately predict the sound power levels for the configuration shown.

3. Provide electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

C. Shop Drawings. Include the following information in the scaled ventilation system shop drawings:

1. Location, orientation and size of fans.

2. Maintenance access and clearance requirements.

3. Fan support methods (i.e. housekeeping pads, roof curbs, etc).

4. Ductwork connections and sizes.

D. Operation and Maintenance (IO&M) Manuals.

1.5 CLOSEOUT SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.

C. Record Documentation: Record actual locations of fans and components and areas required for maintenance access in accordance with Section 200000 - Mechanical General Requirements.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Minimum five years of documented experience manufacturing commercial HVAC fans and related equipment in accordance with AMCA standards.

2. Installers: Minimum five years of experience in the installation of commercial HVAC fan systems.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 200000 - Mechanical General Requirements for general delivery, storage and handling requirements.

B. Storage and Handling Requirements:

1. Maintain fan covers and shrouds in place.

2. Cover fan inlets and outlets to protect components from construction dirt and debris.

1.8 WARRANTY

A. Refer to Section 200000 - Mechanical General Requirements for general warranty requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers:

1. Greenheck.

2. Cook.

3. PennBarry.

4. Acme.

5. AcoustiFLO.

6. Substitution request required.

B. Regulatory Requirements Description:

1. AMCA Certified Ratings seal for sound and air performance.

2. Products Requiring Electrical Connection - Listed and classified by Underwriters Laboratories Inc., or by a testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.

C. Performance/Design Criteria: As scheduled.

D. Manufacturer's Nameplate: Permanently affixed, embossed metal containing model number and individual serial number for future identification, located on a permanent part of the fan.

2.2 IN-LINE CENTRIFUGAL FANS

A. Duct mounted, directdrive, in-line centrifugal type fans. Rectangular fan housing design constructed of heavy gauge galvanized steel with rectangular duct mounting collars.

B. Removable panel in fan cabinet of sufficient size to permit access for service to internal components without dismantling the cabinet.

C. Centrifugal, backward inclined fan wheel constructed of aluminum and matched wheel and inlet cones for precise running tolerances. Dynamically and statically balanced at the factory.

D. Heavy duty ball bearing type fan motors, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drivesreadily accessible for maintenance.

E. NEMA 1 disconnect switch provided as standard, except with explosion resistant motors, where disconnects are optional. Factory wiring provided from motor to the handy box.

F. AMCA Certified Ratings. Seal for both sound and air performance.

2.3 MODULAR SMALL CABINET FAN

A. Cabinet:

1. Materials: Formed double wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections gasketed.

2. Outside Casing: 18 gauge, galvanized steel (G90).

3. Inside Casing: 18 gauge, galvanized steel (G90).

4. Floor Plate: 18 gauge, galvanized steel (G90).

5. Utility Lugs: For lifting unit and fastening to permanent structure, 8 gauge, galvanized steel (G90).

B. Cabinet Insulation. Comply with NFPA 90A or NFPA 90B:

1. Materials: Fiber glass insulation.

2. Thickness: 1 inch.

3. Density: 1-1/2 pounds per cubic foot.

4. Thermal Conductivity (k-Value): 0.26 at 75 degrees F (0.037 at 24 degrees C) mean temperature.

5. Fire-Hazard Classification: Maximum flame spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.

C. Tool less hinged gasketed access doors with latch.

D. Fan Section:

1. Fan Section Construction: Belt driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor drive assembly, and support structure and equipped with formed steel channel base for integral mounting of fan, motor, and casing panels. Mount fan with interior spring vibration isolation.

2. Fan statically and dynamically balanced. Forward Curved Fan Wheels: Galvanized steel and/or aluminum/painted steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

3. AMCA Certified Ratings Seal for air performance.

4. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

5. Turned, ground, and polished (hot rolled) (stainless) steel with keyway. Ship with a protective coating of lubricating oil.

6. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

7. Pre-lubricated and Sealed Shaft Bearings: Self-aligning, pillow block type ball bearings.

8. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

9. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation and with 1.5 service factor based on fan motor.

10. Pulleys: Mechanical cast iron with split, tapered bushing dynamically balanced at factory.

11. Motor Pulleys: Adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

12. Belts: Oil resistant, static free.

13. Motor Mount: Adjustable for belt tensioning.

E. Mixing box with opposed blade low leakage dampers with vinyl edge seals in configuration shown.

F. Filter section with 2 inch filters, maximum face velocity of 350 Feet per minute.

G. Corrosion resistant fasteners.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Coordinate penetration locations with structure.

3.2 INSTALLATION

A. General:

1. Install fans in compliance with manufacturer's written installation instructions.

2. Provide flexible connections at fan duct connections as shown or specified. See Section 233100 - Ducts and Accessories for flexible duct connectors.

3. Support fans independently from ductwork. Provide fan support in accordance with 200529 - Mechanical Hangers and Supports.

4. Provide vibration isolation and seismic restraint for fans in accordance with 200548 - Mechanical Vibration and Seismic Control.

5. Make sure that fan access doors and panels are not obstructed when the equipment is installed.

6. Extend lubrication points so each is easily reached for maintenance.

B. Interface with Other Work:

1. Coordinate and sequence installation of fans with trades responsible for portions of this and other related sections of the Project Manual.

2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate the installation with related work shall be completed at no additional expense to the Owner.

3.3 REPAIR/RESTORATION

A. Refer to Section 200000 - Mechanical General Requirements for general repair/restoration requirements.

3.4 SITE QUALITY CONTROL

A. Manufacturer Services: Verify fans are installed and operational in accordance with the manufacturer's written installation instructions.

3.5 SYSTEM STARTUP

A. Start-up and operate fans in accordance with the manufacturer's written installation and operation manual check list.

3.6 ADJUSTING

A. Adjust and balance fans in accordance with Section 230593 - Testing, Adjusting and Balancing.

3.7 CLEANING

A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down external system components and internal shrouded areas.

3.8 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper system operation in accordance with Section 259000 - Sequence of Operations, utilizing the building automation system.

END OF SECTION 233400

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Single duct variable air volume terminal units.

B. Products Installed But Not Supplied Under This Section: Coordinate installation of damper control actuators and application specific controllers, furnished under Section 255000 - Building Automation System. Control enclosure shall be factory mounted by the air terminal unit manufacturer.

C. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200529 - Mechanical Hangers and Supports
4. 200548 - Mechanical Vibration and Seismic Control
5. 200553 - Mechanical Identification
6. 200700 - Mechanical Insulation
7. 230593 - Testing, Adjusting and Balancing
8. 232113 - Hydronic Piping and Specialties
9. 233100 - Ducts and Accessories
10. 233700 - Air Outlets and Inlets
11. 255000 - Building Automation System
12. 259000 - Sequence of Operations
13. Divisions 26, 27 and 28 - Electrical

1.2 REFERENCES

A. Codes and Standards:

1. SMACNA - HVAC Duct Construction Standards, Metal and Flexible, Third Edition 2005.
2. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

3. ANSI/AHRI 880-2011 - Performance Rating of Air Terminals.

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.

2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.

3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. This section describes specific requirements, products and methods of execution for the single duct, variable air volume, direct digital control terminal units.

2. The method of distribution of air is specified elsewhere.

B. Performance Requirements:

1. Provide product performance characteristics as specified or scheduled on drawings.

2. Operate ventilation system in accordance with Section 259000 - Sequence of Operations.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate and sequence installation of air terminal units with trades responsible for portions of this and other related sections of the Project Manual prior to installation of air terminal units.

1.5 SUBMITTALS

A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data.

C. Shop drawings:

1. This Section shop drawings to be submitted under Section 200000 - Mechanical General Requirements.

2. Include the following information on the scaled ventilation system shop drawings:

a. Air terminal unit locations and sizes, including discharge plenum.
b. Equipment tags.
c. Control enclosure orientation and access clearance requirements.
d. Ductwork connections and sizes.

e. Reheat coil and hydronic piping connections and valving as applicable.
f. Coil access door locations.

D. Installation, Operation and Maintenance (IO&M) Manuals.

1.6 CLOSEOUT SUBMITTALS:

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.

C. Record Documentation.

1.7 QUALITY ASSURANCE:

A. Qualifications:

1. Manufacturers: Minimum five years of documented experience manufacturing the products specified.

2. Installers: Minimum five years of experience in the installation of products specified.

B. Certifications: Air terminal units shall be certified under AHRI Standard 880 Certification Program and carry the AHRI seal.

1.8 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 200000 - Mechanical General Requirements for general delivery, storage and handling requirements.

1.9 WARRANTY

A. Refer to Section 200000 - Mechanical General Requirements for general warranty requirements.

PART 2 - PRODUCTS

2.1 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL UNITS

A. Manufacturers:

1. Titus, Model: DESV.

2. Price.

3. Nailor Industries.

4. Substitution request required.

B. Performance/Design Criteria:

1. Capacities: Provide terminal units of the sizes and performance capacities as scheduled.

2. Sound Rating:

a. Sound data certified by AHRI.
b. Sound ratings for basic air terminal units with inlet diameters less than or equal to 16 inches shall not exceed NC-20 at maximum rated flow (CFM) with a differential static pressure drop of 1.0 inch water column.
c. Sound ratings for basic air terminal units with inlet diameters larger than 16 inches shall not exceed NC-30 at maximum rated flow (CFM) with a differential static pressure drop of 1.0 inch water column.
d. Radiated and discharge sound power levels at maximum air flow operating conditions shall be submitted with product information.

3. Casing Leakage: Less than 2 percent of nominal CFM at 1.5 inches WC differential pressure.

C. Operation by Control Actuator and Application Specific Controller: NEMA 1 control enclosures/digital control packages furnished by Section 255000 - Building Automation System to the air terminal unit manufacturer for factory mounting on side of casing.

D. Materials:

1. Casing:

a. Minimum 22 gauge galvanized steel.
b. Mechanically sealed and gasketed, leak resistant construction.
c. Beaded inlet for low leakage construction, sized to fit standard round duct.
d. Rectangular discharge opening designed for slip and drive cleat connection to low pressure ductwork or reheat coil.
e. Multi-port, center averaging inlet velocity sensor with sensor tubing. Flow measurement taps provided for connection to application specific controller.
f. Internally line casing with sound liner specified below.

2. Control Damper:

a. Heavy gauge galvanized steel, butterfly type damper.
b. One-piece, 1/2-inch diameter damper shaft with self-lubricating Delrin® or bronze oilite bearings. Notched shaft end, to indicate damper position.
c. Synthetic damper seal to limit close-off leakage to less than 1% of terminal rated airflow at 3.0 inches water column differential pressure.
d. Mechanical stop to prevent damper over-stroking.

3. Duct Transitions:

a. Provide rectangular reheat coil discharge plenum:
   1). Minimum width to match reheat coil width.
   2). Minimum height to match reheat coil height or maximum downstream branch duct spin-in connection diameter plus 4 inches, whichever is greater.
   3). Minimum length 36 inches or longer to accommodate branch ducts.

b. Sound line duct transitions and plenums to match terminal unit casing liner.

E. Accessories:

1. Sound Liner:

a. UL Listed and in conformance with NFPA Standard 90A. Liners shall be fungi and bacterial resistant.
b. 1-inch thick fiber-free closed cell foam insulation, minimum 1-1/2 pound per cubic foot density, mechanically fastened to unit casing.
c. Cut liner edges and seal to prevent erosion with discharge edges secured with metal barrier strips for fiberglass or similar insulation.

2. Hydronic Reheat Coils:

a. Performance characteristics as scheduled.
b. Constructed from seamless copper tubing (minimum 0.016-inch wall thickness) with aluminum fins, enclosed in 20 gauge (minimum) galvanized steel casing with slip and drive connections. Provide extended copper sweat connections.

3. Access Doors: Provide access doors upstream and downstream of reheat coils for coil cleaning. Refer to Section 233100 - Ducts and Accessories.

2.2 EXHAUST/RETURN AIR FLOW CONTROL VALVES

A. Manufacturers:

1. Titus, Model DECV (Basis of Design).

2. Price.

3. Siemens Apogee.

B. Electronically actuated, pressure independent airflow control valves.

C. Constructed of 22-gauge galvanized steel with heavy gauge steel damper and shaft with Delrin® self-lubricating bearings. Notched shaft end to indicate damper position and mechanical stop to prevent overstroking.

D. Accuracy and performance.

1. Multi-port, center averaging flow sensor with sensor tubing with flow measurement taps for connection to application specific controller.

2. Flow accuracy: AMCA certified, plus/minus 5 percent flow accuracy over entire flow range of valve.

3. Air flow turn down ratio: 5 to 1 minimum turn down.

4. Synthetic seal limits close-off damper leakage to a maximum of 7 CFM at a differential pressure of 3 inches water column static pressure.

5. Control response time: 10 seconds maximum cycle time between minimum and maximum flow values.

6. Maximum pressure drop: 0.5 inches at maximum rated airflow.

7. Accuracy and performance guaranteed regardless of field conditions.

E. Control Actuator and Application Specific Controller.

1. Furnished directly to the air terminal unit manufacturer for factory installation by Section 230900 - Building Automation System.

F. Exhaust airflow measurement shall be provided by techniques that minimally obstruct the exhaust duct. Pitot tube arrays are NOT acceptable for exhaust airflow measurement.

G. Air flow monitoring.

1. Provide monitoring of airflow through air valve.

2. Transmit signal to room controller on loss, increase and/or decrease of airflow.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in ventilation system construction and under the supervision of a qualified installation supervisor.

3.2 PREPARATION

A. Protection of In-Place Conditions: Cover air terminal unit inlet and discharge openings to protect components from construction dirt and debris.

3.3 INSTALLATION

A. General:

1. Install air terminal units in strict compliance with the manufacturer’s written installation instructions.

2. Do not locate any part or the terminal unit assembly, including reheat coil and associated low pressure sound lined plenums, such that it passes over a partition wall or through a full height wall penetration.

3. Locate terminal units such that the bottom of the complete assembly is 6 to 18 inches above the top of the ceiling grid or hard lid ceiling framing as applicable.

4. Locate terminal unit controller, coil hydronic piping/valves, and coil access doors on same side of unit. Locate on side that maximizes accessibility (i.e. above accessible ceiling tiles, away from full height walls and main duct runs).

5. Support air terminal units independent of duct system. Provide sway bracing within 12 inches of support attachment.

6. Connect air terminal unit inlets to ductwork using straight sections of unrestricted rigid duct of the same inlet diameter as terminal unit inlet. Provide a minimum straight duct length of 4 duct diameters at each terminal unit inlet. Medium pressure flexible duct connections to terminal units is not allowed except where specifically shown.

7. Close-coupling of a terminal inlet to the side of a main supply duct is not acceptable without written permission from the Contracting Agency. When this method is approved, provide an inlet flow straightening device.

8. Install low pressure ductwork branches vertically centered along the sides of the low pressure sounded lined plenum. A minimum of two (2) inches of sheet metal is required between the spin-in (or similar connection) and top and bottom external edge of the metal plenum.

9. Provide insulated access doors upstream and downstream of reheat coil for coil cleaning.

10. Secure control enclosure cover in place as intended by the manufacturer.

11. Verify mechanical connections, electrical and control wiring and sensor tubing are properly secured.

B. Interface with Other Work:

1. Coordinate and sequence the installation of air terminal units with trades responsible for portions of this and other related sections of the Project Manual.

2. Coordinate ceiling and/or wall access panel locations to provide convenient maintenance and cleaning access for each air terminal unit.

3. Coordinate air terminal unit locations with ceiling grids, lighting troffers, air outlets and return grilles to maximize accessibility and minimize interference.

4. Rework required as a result of failure to follow the manufacturer’s written installation instructions, properly coordinate the installation with related work, or provide adequate access (as determined by the Contracting Agency) shall be completed at no additional cost to the Owner.

3.4 REPAIR/RESTORATION

A. Refer to Section 200000 - Mechanical General Requirements for general repair/restoration requirements.

3.5 SYSTEM START-UP

A. With the applicable central ventilation system air balancing completed and the ventilation system operating under automatic control utilizing the BAS, cycle each air terminal unit control damper between minimum and maximum scheduled air flow settings to demonstrate proper operation and capacity in accordance with 259000 - Sequence of Operations for verification by the Contracting Agency.

B. Verify reheat coil and auxiliary heating unit (as applicable) hydronic control valves properly cycle with terminal unit control damper, in accordance with Section 259000 - Sequence of Operations.

3.6 ADJUSTING

A. Adjust velocity sensor bias adjustment as necessary to provide accurate air flow measurement.

3.7 CLEANING

A. Upon completion of installation and prior to initial operation, vacuum clean and wipe down air terminal units and control enclosures.

B. Remove any debris from control enclosure.

C. Inspect and clean reheat coils. Re-straighten coil fins if necessary.

END OF SECTION 233600

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air Diffusers and Registers.
2. Return/Exhaust Grilles.
3. Wall Caps.
4. Stationary Louvers.

B. Related Sections:

1. 200000 - Mechanical General Requirements
2. 200529 - Mechanical Hangers and Supports
3. 230593 - Testing, Adjusting and Balancing
4. 233100 - Ducts and Accessories

1.2 REFERENCES

A. Codes and Standards:

1. SMACNA HVAC Duct Construction Standards - Metal and Flexible Third Edition 2005.
2. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
3. ARI Standard 890-2001 - Air Diffusers and Air Diffuser Assemblies.

1.3 PREINSTALLATION MEETINGS

A. Coordinate and sequence installation of air diffusers, registers, grilles, and louvers with trades responsible for portions of this and other related sections of the Project Manual prior to installation of air outlets and inlets.

1.4 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Air outlets and inlets performance data at operating conditions.

2. Submit color selections for louvers which match exterior architectural wall panels.

3. Submit color selections for diffusers, registers, and grilles for Architectural selection.

C. Shop Drawings:

1. This Section shop drawings to be submitted under Section 200000 - Mechanical General Requirements.

2. Include the following information on scaled ventilation system shop drawings:

a. Air diffuser, register and grille locations, duct connection sizes and throw directions.
b. Louver locations with plenum dimensions.
c. Louver penetration detail which clearly shows wall type, louver frame type, duct connection method, sealant and or gasket locations and drainage path.

D. Test and Evaluation Reports:

1. Louver plenum water tightness test: Submit written certification that louver plenums have been satisfactorily tested and have been verified water-tight prior to insulating plenums. Refer to louver test under Part 3 below.

E. Installation, Operation and Maintenance (IO&M) Manuals.

1.5 CLOSEOUT SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.

C. Record Documentation.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Minimum five years of documented experience manufacturing the products specified.

2. Installers: Minimum five years of experience in the installation of products specified.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 200000 - Mechanical General Requirements for general delivery, storage and handling requirements.

1.8 WARRANTY

A. Refer to Section 200000 - Mechanical General Requirements for general warranty requirements.

PART 2 - PRODUCTS

2.1 AIR DIFFUSERS AND REGISTERS

A. Manufacturers:

1. Titus (Basis of Design).

2. Price.

3. Nailor Industries Inc.

4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Performance/Design Criteria: As scheduled.

C. Finishes: Standard white, baked enamel or powder coated finish suitable for field application of custom finish color as required. Coordinate with Architect for color selection.

D. Accessories:

1. Equalizing grids.

2. Earthquake tabs.

E. Correlate diffuser style, dimension, and fit with ceiling. Provide diffusers with modules of the proper size to match the suspended ceiling layout or with appropriate factory provided frame for surface mounting.

2.2 RETURN/EXHAUST GRILLES

A. Manufacturers:

1. Titus (Basis of Design).

2. Price.

3. Nailor Industries Inc.

4. Any other manufacturer meeting the requirements of the Contract Documents. Substitution request not required.

B. Performance/Design Criteria: As scheduled.

C. Finishes: Standard white, baked enamel or powder coated finish suitable for field application of custom finish color as required. Coordinate with Architect for color selection.

D. Accessories: Earthquake tabs.

E. Correlate grille style, dimension, and fit with ceiling. Provide grilles with modules of the proper size to match the suspended ceiling layout or with appropriate factory provided frame for surface mounting.

2.3 WALL CAPS

A. Manufacturers: Broan (Basis of Design) or approved equal.

B. Description: Dryer and residential kitchen hood exhaust termination wall cap. Coordinate size with dryer and kitchen hood vent. Do not provide with mesh screen.

C. Materials: Aluminum.

D. Finish: Natural aluminum finish.

E. Accessories: Backdraft damper.

2.4 WALL LOUVERS

A. Manufacturers:

1. Ruskin (Basis of Design).

2. Greenheck.

3. Pottorff.

4. Substitution request required.

B. Description:

1. General:

a. Six inch deep, stationary wall louvers.
b. Horizontal drainable blades (37.5 degree blade angle) with integral downspouts incorporated into frame jamb and mullion design.
c. Frame style designed for installation into wall penetration construction type indicated. See Architectural penetration details to coordinate style types.
d. Louver frame with surfaces designed to accept exterior caulking.

2. Regulatory Requirements:

    a. Louvers shall bear the AMCA Certified Ratings label for Water and Air Performance.
    b. Manufacturer's ratings based on testing in accordance with AMCA Publication 511.

C. Performance/Design Criteria:

1. Size and performance as scheduled.

2. Water penetration: 0.01 ounces of water per square foot of free area at 1000 FPM free area velocity.

D. Materials: Heavy gauge extruded aluminum.

E. Finishes:

1. Standard Finish: Baked enamel (fluoropolymer). Color selected by Architect.

F. Accessories:

1. Bird Screens: Flattened, expanded aluminum with 1/2 inch mesh pattern. Located on internal side of louver assembly.

2. Blank-off Panels:

    a. Provide factory installed, insulated blank-off panels as scheduled and/or as shown.
    b. Paint exterior side of blank-off panel flat black.
    c. Field installed blank-off panels are not acceptable.

3. Extended Sills: Extruded aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install products in compliance with the manufacturer's written installation instructions.

2. Connect air outlets, registers, grilles and louvers to ventilation duct systems in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Air Diffusers, Registers and Grilles:

1. Install air diffusers, registers and return/exhaust grilles at the locations shown.

2. Orient and adjust diffusers to provide the throw directions indicated.

3. Provide appropriate borders for the ceiling, wall or floor construction type.

C. Wall Caps:

1. Coordinate flashing and counterflashing with architectural.

D. Wall Louvers:

1. Install wall louvers at the locations shown and in accordance with manufacturer's written installation instructions and details for the specific wall type.

2. Coordinate louver locations, borders and mullion spacing with architectural panels.

3. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.

4. Seal louver penetrations watertight. Install, seal and insulate louver ductwork (intake or exhaust/relief plenums) to interior louver frame to prevent condensation or entrained water that enters ductwork from leaking into building. Provide sleeves, special connections and sealant as required to accomplish this requirement.

5. Slope plenum ductwork such that any entrained water drains out through base frame of wall louver. If drain holes are not provided by the manufacturer, drill 1/2-inch (minimum diameter) weep holes at twelve (12) inch intervals on center through base of louver as required for drain water to escape. Touch-up holes with factory supplied touch-up paint.

3.2 REPAIR/RESTORATION

A. Refer to Section 200000 - Mechanical General Requirements for general repair/restoration requirements.

3.3 SITE QUALITY CONTROL

A. Site Tests and Inspections: Prior to insulating louver intake and exhaust/relief plenums, with applicable fans shutdown, lightly spray water into louver from building exterior such that water enters plenums. Verify that the water readily drains out of louver drain holes without pooling and that no visible leakage is present. Repair and retest as necessary until performance requirements are met.

3.4 CLEANING

A. Clean exposed surfaces of air outlets and inlets, with water and mild soap or detergent not harmful to finish, in order to remove fingerprints and dirt.

END OF SECTION 233700

SECTION 235100 - BREECHINGS, CHIMNEYS AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Boiler venting system.

B. Related sections:

1. 200000 - Mechanical General Requirements
2. 200529 - Mechanical Hangars and Supports
3. 200548 - Mechanical Vibration and Seismic Control
4. 235223 - Cast Iron Boilers and Accessories

1.2 REFERENCES

A. Codes and Standards:

1. International Mechanical Code (IMC).
2. Uniform Plumbing Code (UPC).

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.
2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.
3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: This section describes specific requirements, products and methods of execution for boiler systems.

B. Performance Requirements: Provide product performance characteristics as specified or scheduled on drawings.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate installation of boiler venting systems with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

1.5 SUBMITTALS

A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Provide manufacturers' product literature.

2. Annotate to indicate specified salient features and performance criteria for each product specified.

C. Calculations:

1. Provide calculations from the stack manufacturer based on the submitted stack shop drawings and submitted and approved boiler draft requirements to demonstrate adequate draft available at the following conditions:

Boiler Firing Rate	**Outdoor Air Conditions**
High Fire	-4 deg F
Low Fire	-4 deg F
High Fire	68 deg F
Low Fire	68 deg F

D. Shop Drawings:

1. Submit fully dimensioned shop drawings of boiler room(s) showing the following:

a. Major equipment and housekeeping pads, with clear callouts indicating deviations from layout shown:
   1). Submitted boiler shall be dimensionally equal to scheduled product within 6 inches in each dimension. Maintain clearances shown on drawings. Submit fully dimensioned shop drawings of boiler room(s) at drawing scale of 1/4-inch equals 1 foot 0 inches or larger, showing entire boiler room, equipment and deviations. Provide boiler room modifications required due to dimensional and technical deviation at no additional cost to the Owner. Submit shop drawings of proposed equipment layout and base or pad for each piece of equipment.
   2). If equipment to be provided exceeds the weight of the specified equipment by more than 20 percent, or if the location is to be altered, submit shop drawings and calculations of proposed revised structural design, noting location of pertinent loads, stamped by a registered professional engineer.

b. Service area boundaries as required by manufacturer's installation.
c. Boiler piping and vent stack locations with dimensions. Coordinate stack roof penetrations with roof structure.

d. Indicate mechanical and electrical service locations and requirements.

1.6 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance (IO&M) Manuals:

1. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.

2. Include the following:

a. Copies of approved submittal information.
b. Manufacturer's installation, operating and maintenance/repair instructions, parts listings, and spare parts list for each product. Annotate the manual to indicate applicable information for the specific equipment model(s) installed.

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.

C. Record Documentation: Record actual locations of equipment, piping, and components and areas required for maintenance access in accordance with Section 200000 - Mechanical General Requirements.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer qualifications: Company specializing in manufacturing the products specified in this section with minimum 3 years documented experience.

2. Installers: Minimum 3 years' experience in the installation of commercial HVAC ductwork and related products.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Verify products are new and delivered in original factory packaging/crating and are free from damage and corrosion.

2. Replace products delivered to job site that does not comply with above requirements at no expense to Owner.

B. Storage and Handling Requirements:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.9 WARRANTY

A. Manufacturer Warranty:

1. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

2. Provide 1-year manufacturer's warranty.

PART 2 - PRODUCTS

2.1 BOILER VENTING (CHIMNEY) SYSTEM

A. Manufacturers:

1. Schebler, model P1.

2. Selkirk Metalbestos.

3. AMPCO (American Metal Products Company).

4. Cleaver Brooks.

5. ICC (Industrial Chimney Company).

6. Van Packer.

B. Description:

1. Provide complete, engineered venting system for oil fired equipment, including connections and adapters to smoke outlets.

2. Provide prefabricated chimney system of the size and configuration shown.

3. Provide supports and seismic restraints in accordance with the manufacturer's UL listing, Section 200529 - Mechanical Hangers and Supports, and Section 200548 - Mechanical Vibration and Seismic Control.

4. Regulatory Requirements:

a. UL listed for application.
b. Listed for pressurized systems.

C. Materials:

1. 316 Stainless steel liner.

2. Stainless steel outer jacket where exposed to outdoors.

3. Aluminized steel outer jacket where located indoors.

D. Assembly/Fabrication:

1. 1-inch fiber insulation between inner and outer stack walls.

2. Clean-out tee with ball isolation valve, threaded hose connection and end cap

3. Roof thimble (Coordinate required thimble rough-in dimensions with roof penetration requirements and structural bracing).

4. Stack cap.

5. Stainless steel flashing and counter flashing.

6. Pre-manufactured support brackets.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Installer: Perform work by experienced personnel under the supervision of a qualified installation supervisor.

3.2 PREPARATION

A. Surface Preparation: Prior to installation of stacks, verify that shop drawings are approved, and stack locations and routing have been coordinated with other trades.

3.3 INSTALLATION

A. Special Techniques:

1. Install equipment in accordance with manufacturer’s instructions and requirements of the codes specified herein.

2. Install with clearances from building elements in accordance with chimney listing and IMC.

3. Install components that were furnished loose with equipment for field installation.

4. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.

B. Interface with Other Work: Coordinate and sequence installation of boiler and water heater and stacks with trades responsible for portions of this and other related sections of the Project Manual.

3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.5 SITE QUALITY CONTROL

A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

3.6 CLEANING

A. Waste Management: After construction is completed, clean and wipe down exposed surfaces of boiler or water heater stacks

END OF SECTION 235100

SECTION 235223 - CAST IRON BOILERS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Packaged hydronic boilers and appurtenances.
2. Fuel oil burners.
3. Packaged boiler control system.

B. Related sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200529 - Mechanical Hangars and Supports
5. 200548 - Mechanical Vibration and Seismic Control
6. 200553 - Mechanical Identification
7. 230593 - Testing, Adjusting and Balancing
8. 231113 - Fuel Oil Piping and Specialties
9. 232113 - Hydronic Piping and Specialties
10. 232123 - Hydronic Pumps
11. 235100 - Breechings, Chimneys and Stacks
12. 255000 - Building Automation System
13. 259000 - Sequence of Operations
14. Divisions 26, 27 and 28 - Electrical

1.2 REFERENCES

A. Codes and Standards:

1. International Mechanical Code (IMC).

2. Uniform Plumbing Code (UPC).

3. NFPA 31 - Installation of Oil-Burning Equipment.

4. ASME Boilers and Pressure Vessel Code (1998), Sections IV & VI.

5. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers.

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.

2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.

3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. This section describes specific requirements, products and methods of execution for the generation of heat, which will be distributed to the locations shown.

2. The method of distribution of this heat is specified elsewhere.

B. Performance Requirements:

1. Provide product performance characteristics as specified or scheduled on drawings.

2. Operate central heating system in accordance with Section 259000 - Sequence of Operations.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate installation of boilers and associated piping and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

1.5 SUBMITTALS

A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria to include:

   a. Product model and selected optional equipment, appurtenances and special features.
   b. Boiler physical and performance characteristics as scheduled.
   c. Include weight of equipment filled with water. Boilers weighing more than 20 percent heavier than the schedule equipment will be disapproved unless it is determined by the Owner's representative that structure is able to bear the additional weight. Contractor may elect to increase structural support, in which case proposed changes to the structure and calculations stamped by a registered engineer shall be submitted.
   d. Dimensional data.
   e. Anchoring method.

2. Regulatory Requirements: Provide automatic boiler controls listed in the Mechanical Code and ASME CSD-1, latest edition, together with most current addenda and interpretations.

C. Shop Drawings:

1. Submit fully dimensioned shop drawings of boiler room(s) showing the following:

   a. Major equipment and housekeeping pads, with clear callouts indicating deviations from layout shown:
      1). Submitted boiler shall be dimensionally equal to scheduled product within 6 inches in each dimension. Maintain clearances shown on drawings. Submit fully dimensioned shop drawings of boiler room(s) at drawing scale of 1/4-inch equals 1 foot 0 inches or larger, showing entire boiler room, equipment and deviations. Provide boiler room modifications required due to dimensional and technical deviation at no additional cost to the Owner. Submit shop drawings of proposed equipment layout and base or pad for each piece of equipment.
      2). If equipment to be provided exceeds the weight of the specified equipment by more than 20 percent, or if the location is to be altered, submit shop drawings and calculations of proposed revised structural design, noting location of pertinent loads, stamped by a registered professional engineer.

   b. Service area boundaries as required by manufacturer's installation.
   c. Boiler piping and vent stack locations with dimensions. Coordinate stack roof penetrations with roof structure.
   d. Indicate mechanical and electrical service locations and requirements.
   e. Boiler management system location.

D. Manufacturer Reports:

1. Provide start-up and operational test reports for each boiler. Refer to Article on Site Quality Control.

2. Provide start-up report for boiler control system with selected presets annotated.

3. Submit a letter to document that the training was conducted. Include in the letter the date, start/stop times for the training, list of attendees and signature/title of the person(s) providing the training.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance (IO&M) Manuals:

1. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.

2. Include the following:

a. Copies of approved submittal information.
b. Manufacturer’s installation, operating and maintenance/repair instructions, parts listings, and spare parts list for each product. Annotate the manual to indicate applicable information for the specific equipment model(s) installed.
c. Computer software manuals and applicable licenses.
d. Completed start-up and operational test report as required to validate equipment warranty.
e. Start-up and operational test reports for each boiler. Report shall include printed names and signatures of the installers and documentation that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
f. Start-up report for boiler and combustion management system with selected presets annotated.

B. Warranty Documentation: Provide standard manufacturer’s warranty and submit documentation in accordance with Section 200000.

C. Record Documentation: Record actual locations of equipment, piping, and components and areas required for maintenance access in accordance with Section 200000 - Mechanical General Requirements.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years’ documented experience.

2. Installers:

a. Minimum 3 years’ experience in the installation and start-up of boilers.
b. A factory-authorized technician shall perform boiler startup service.
c. The manufacturer's authorized technician shall supervise the installation, startup, programming, and adjustment of the Boiler Management System.

3. Testing Agencies: Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and as indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Verify products are new and delivered in original factory packaging/crating and are free from damage and corrosion.

2. Replace products delivered to job site that does not comply with above requirements at no expense to Owner.

B. Storage and Handling Requirements:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.9 WARRANTY

A. Manufacturer Warranty:

1. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

2. Provide 1-year manufacturer’s warranty.

3. Submit necessary documentation to the Manufacturer’s Representative to validate manufacturer’s warranty.

4. Provide to the Contracting Agency 1 copy of warranty documentation and confirmation receipt from the Manufacturer’s Representative.

PART 2 - PRODUCTS

2.1 HOT WATER BOILER - CAST IRON

A. Manufacturers:

1. Weil-McLain.

2. Burnham.

3. H. B. Smith.

B. Description:

1. Factory assembled, sectional, wet base, cast iron boilers.

2. Suitable for forced draft firing.

C. Performance/Design Criteria: The thermal output of each boiler shall not be less than and no more than 10 percent greater than the values scheduled. Required thermal capacity shall be the gross I=B=R water rating.

D. Assembly/Fabrication:

1. Insulated metal jacket.

2. Burner mounting plate.

3. Gas tight seal between sections.

4. Flue damper assembly with valved test connection.

5. ASME safety relief valve (30 psig).

6. Low point system drain valve with end cap.

7. Flange mounted oil burner.

8. Instrument panel for each boiler complete with the following:

a. Fire box draft gauge.
b. Stack draft gauge.
c. Stack temperature gauge.
d. Boiler supply temperature gauge.
e. Boiler return temperature gauge.
f. Burner running time totalizer.

9. Provision for anchoring boiler to its housekeeping pad adequate to meet seismic requirements. Refer to Section 200548 - Mechanical Vibration and Seismic Control.

10. Additional components as necessary to provide a complete operational system.

2.2 FUEL OIL BURNER

A. Manufacturer:

1. Powerflame.

2. Weishaupt.

3. Approved equal.

B. Description: Fully packaged boiler and forced draft fuel oil burner, with burner mounted and wired to boiler controls, complete with control transformer.

C. Performance/Design Criteria: Size forced draft fuel oil burner to match boiler rating.

D. Assembly:

1. UL/FM listed as a complete unit.

2. Firing control: 3 stage.

3. Peripheral controls to include:

   a. Operating temperature controller.
   b. High limit control with manual reset.
   c. Honeywell L4006E auxiliary high limit control.
   d. Low water safety shut-off control.

4. Provide dry contacts for:

   a. Flame failure relay monitoring.
   b. Lock out alarm.
   c. Boiler status monitoring by Building Automation System.

5. Honeywell Model RM-7895 Flame Safeguard System with self-diagnostic capabilities. Provide one digital display readout module to be shared by the boilers.

6. Burner cabinet mounted three position switch for local burner control. Label switch positions “ON”, “OFF” and “AUTO.” In “AUTO” mode, burner is controlled through the Building Automation System.

7. Provide wiring to connect boiler peripheral controls and safety devices to appropriate burner controls and building automation system in accordance with applicable provisions of Divisions 26, 27 and 28.

8. Provide electrical leads long enough to allow the burner to hinge fully open.

9. Indicators and alarms shall include; power on, run, lock out, and other indicating lights as applicable. Lock out indicator shall have provision for connection to a remote alarm or monitoring device and burner firing control shall have provision for controlling boiler shut-off valve through the BAS control system.

10. The boiler controls specified in this section shall be fully coordinated with the BAS control system specifications.

11. Since boilers will operate in response to supply header temperature sensed by the BAS control system, the operating temperature controller, shall be selected and wired to function as an automatically resetting, first stage limit control. Coordinate with sequence of operation specified in Section 259000 - Sequence of Operations.

2.3 LOW WATER CUTOFF

A. Manufacturers:

1. McDonnell Miller.

2. Approved equal.

B. Description: Model #63M low water cut-off device for each boiler.

C. Performance/Design Criteria:

1. 50 psig working pressure.

2. UL/FM approved.

D. Operations: Wired in series with burner control.

E. Accessories: McDonnell Miller TC-4 test and check assembly.

2.4 AUXILIARY HIGH LIMIT

A. Manufacturers:

1. Honeywell.

2. Approved equal.

B. Description: Model L4006E auxiliary high limit sensor for each boiler.

C. Operations: Monitor boiler auxiliary high limit from BAS. See Section 259000 - Sequence of Operations.

2.5 EMERGENCY BOILER SHUTOFF

A. Provide an emergency boiler shutoff switch. See Division 26.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in boiler plant construction and under the supervision of a qualified installation supervisor.

3.2 PREPARATION

A. Protection of In-Place Conditions: Cover boilers and burners and plug piping connections to protect equipment from construction dirt and debris.

B. Surface Preparation:

1. Prior to installation of boilers, verify concrete housekeeping pads are complete and properly sized for boiler mounting.

2. Prior to installation of stacks, verify that shop drawings are approved and stack locations and routing have been coordinated with required roof penetrations and the work of other trades.

3.3 INSTALLATION

A. Special Techniques:

1. Install equipment in accordance with manufacturer's instructions and requirements of the codes specified herein.

2. Install boiler control system in accordance with manufacture's installation instructions. Connect each of the boilers to the control system. Program control system to maintain boiler water temperature control as described in Sequence of Operation.

3. Connect to the building automation system.

4. Setting of equipment:

a. Set equipment on concrete housekeeping pads compatible with the building structural system.
b. Level equipment to within recommended tolerances.

5. Anchoring:

a. Anchor boilers to housekeeping pads as recommended by the manufacturer and to allow for normal expansion and contraction.
b. Coordinate with Section 200548 - Vibration and Seismic Control.

6. Thermal expansion:

a. Install hydronic piping to allow for normal thermal expansion and contraction.
b. Provide anchors where necessary and as indicated.
c. Provide expansion loops, anchors and alignment guides to suit conditions and as indicated.

7. Install components that were removed from equipment for shipping purposes.

8. Install components that were furnished loose with equipment for field installation.

9. Provide interconnecting electrical control and power wiring.

10. Provide fuel oil vent and service piping.

11. Provide piping for boiler pipe connections.

12. Program, adjust and operationally test boiler operation and sequencing in accordance with the manufacturer's written installation and testing instructions and Section 259000 - Sequence of Operations.

13. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.

14. Install emergency boiler shutoff switch inside the boiler room at each exit at 48 inches above finished floor.

B. Interface with Other Work: Coordinate and sequence installation of boilers and stacks with trades responsible for portions of this and other related sections of the Project Manual.

C. Systems Integration: Coordinate location and operation of boiler emergency shutoff switch(es) with Divisions 26, 27 and 28.

3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.5 SITE QUALITY CONTROL

A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer’s written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

B. Manufacturer Services:

1. Provide manufacturer's representative start-up and instruction of each complete boiler system including all components assembled and furnished by the manufacturer whether or not of his own manufacture.

2. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization.

3. Start-up and adjust the system to within the tolerances as specified by the equipment manufacturer.

4. Operationally test safety devices and record settings. Test and record oxygen, carbon dioxide, stack temperature, and calculate excess air and steady state efficiency. Make final lead/lag set point adjustments. List set points in report. Submit final data for review.

5. Test boiler operation and sequencing in accordance with the manufacturer's written installation and testing instructions and Section 259000 - Sequence of Operations.

6. Provide a start-up report that includes final control settings, and a performance chart of the control system furnished.

7. Submit a letter of certification with copy of start-up report, indicating that the boiler start-up has been completed, that the boilers are properly adjusted and operating within the tolerances as specified by the manufacturer, and that the sequence of operation is fulfilled.

3.6 ADJUSTING

A. Coordinate and work directly with the requirements of Section 230593 - Testing, Adjusting and Balancing, to provide systems in proper operating order.

B. Make corrections and adjustments as required by the Testing, Adjusting and Balancing (TAB) Agency in a timely manner.

3.7 CLEANING

A. After construction is completed, clean and wipe down exposed surfaces of boilers and burners.

3.8 CLOSEOUT ACTIVITIES

A. Demonstration: Provide 2 hours of demonstration conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

B. Training: Provide 2 hours of operational instruction conducted by authorized factory start-up personnel to the Contracting Agencies authorized maintenance personnel.

END OF SECTION 235223

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 236400 - PACKAGED WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Design, performance criteria, refrigerants, compressor type(s), starter type(s), controls, and installation for packaged air-cooled chiller units.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200548 - Mechanical Vibration and Seismic Control
4. 200553 - Mechanical Identification
5. 200700 - Mechanical Insulation
6. 230593 - Testing, Adjusting and Balancing
7. 232113 - Hydronic Piping and Specialties
8. 259000 - Sequence of Operations

1.2 REFERENCES

A. Comply with latest applicable Standards/Codes:

1. AHRI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle
2. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
3. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration
4. ANSI/ASHRAE 34 - Number Designation and Safety Classification of Refrigerants
5. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings
6. ANSI/NFPA 70 - National Electrical Code (NEC)
7. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
8. OSHA - Occupational Safety and Health Act

9. Manufactured in facility registered to ISO 9001

10. ANSI/ASHRAE 15 Safety Standard for Refrigeration Systems.

11. ETL/cETL.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Provide complete packaged air-cooled chiller units utilizing scroll compressor technology as scheduled, specified herein, and as shown on the Drawings.

2. The unit shall be constructed and operate in accordance with the referenced design standards and with local Codes in effect.

B. Performance Requirements:

1. Refer to the schedule of performance on the Drawings.

2. The unit shall be capable of stable operation to a minimum of approximately 15 percent of full load without hot gas bypass.

3. Performance shall be in accordance with ARI Standard 365-94 and as indicated herein and on the drawings.

1.4 SUBMITTALS

A. Product Data:

1. Provide submittal data in accordance with the general requirements of Section 200000 – Mechanical General Requirements.

2. Include the additional submittal information specific to the equipment specified by this section as followings:

a. Provide manufacturer's literature that fully demonstrates compliance with the manufacturing methods, appurtenances, and salient features specified.
b. Provide sound power level data (decibels) for each octave band for the equipment.
c. Provide electrical connection requirements.
d. Provide electrical power connection and control logic wiring diagrams. Diagrams shall differentiate between factory installed and field installed wiring.

B. Substitutions:

1. Proposed substitutions shall meet:

a. Performance requirements as scheduled (as a minimum).
b. Unit size, weight, and electrical load limitations as required for this project.
c. The specification requirements of this section.

2. Specifically, substitution units shall be provided with (no exceptions):

    a. Adjustable soft-start compressor starters.
    b. An integral “Return Chilled Liquid Control” mode or a pre-approved master/slave central chilled water control plant function acceptable to the Owner.

3. Cost of design modifications as a result of proposed product substitutions shall be borne by the Contractor.

C. Shop Drawings:

1. Provide dimensional and orientation information (plan and elevation) for the approved chiller and incorporate into the enlarged mechanical room shop drawings.

2. Indicate overall dimensions, access door locations, and piping and electrical connection points.

3. Label chillers as scheduled.

D. Operation and Maintenance (O&M) Manual:

1. Provide a complete copy of the manufacturer’s written installation, operation and maintenance manual to include the following information:

    a. Manufacturer’s descriptive literature.
    b. Installation instructions.
    c. Operating instructions.
    d. Troubleshooting guide.
    e. Preventative maintenance requirements.
    f. Parts list.
    g. Recommended spare parts list.

2. Neatly annotate the O&M manual to clearly indicate information applicable to the equipment installed.

E. Closeout submittals:

1. Project record drawings: Annotate a clean copy of the project Contract Drawings to clearly indicate the actual installation of the units.

2. Submit a certificate from the Manufacturer’s Representative indicating that the chillers are installed and operational in accordance with the manufacturer’s written installation, operation and maintenance manual and the specified sequences of operation.

3. Submit one copy of warranty documentation and receipt confirmation from the Manufacturer’s Representative.

1.5 QUALITY ASSURANCE

A. Manufacturer qualifications: Company specializing in manufacturing the products specified in this section with a minimum of three years' documented experience with similar equipment and the refrigerant offered.

B. Installer qualifications: Minimum three years' experience in the installation welded steel piping and the installation and start-up of packaged chillers.

C. Regulatory Requirements: Products Requiring Electrical Connection – Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

D. Factory Run Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel prior to shipment.

E. Chiller manufacturer shall have a factory trained and supported service organization permanently based in the State of Alaska.

1.6 DELIVERY AND HANDLING

A. Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant and oil by the Manufacturer.

B. Provide protective covering over vulnerable components for unit protection during shipment. Fit nozzles and open ends with plastic enclosures. See Accessories and Options section herein.

C. Unit shall be stored and handled per Manufacturer's instructions.

D. Acceptance at Site:

1. Verify chiller units are delivered in original factory packaging/crating and are free from damage and corrosion.

2. Comply with the manufacturer's instructions for rigging and handling.

3. Replace equipment or parts delivered to job site that do not comply with above requirements at no expense to Owner.

E. Storage and Protection: Store products in temporary protected storage area(s) while in transit to the site. Store on-site as directed by the Owner.

1.7 WARRANTY

A. Manufacturer shall warrant all equipment and material of its manufacture against defects in workmanship and material for a period of 18 months from date of shipment or 12 months from date of start-up, whichever occurs first.

B. Provide optional three year parts only warranty for compressors. See Accessories and Options below.

1.8 MAINTENANCE

A. After acceptance by the Owner, maintenance of the chiller units shall be the responsibility of the Owner and performed in accordance with the manufacturer's instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Multistack (Basis of Design).

B. York.

C. McQuay.

D. Trane.

E. Pre-approved equal.

2.2 AIR COOLED SCROLL COMPRESSOR WATER CHILLER

A. External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 1,000 hour, 5 percent salt spray test, yields minimum ASTM 1654 rating of "6".

B. Compressors shall be mounted on neoprene vibration isolators and arranged to be accessible for removable without disassembly of the unit. Compressors shall be of the hermetic, scroll type with discharge check valves, forced feed lubrication, crankcase heaters, brazed-type connections, and initial oil charge. Suction and discharge service valves, suction strainer, oil strainer, oil sight glass, and oil charging connection. Refrigerant cooled motors with motor overloads capable of monitoring compressor motor current to provide protection against compressor reverse rotation, phase-loss, and phase-imbalance.

C. Provide solid state soft-start motor starters for all compressors that include self-diagnostics, metering, ground fault, and phase/voltage protection.

D. Evaporator:

1. Evaporator shall be brazed-plate stainless steel construction capable of refrigerant working pressure of 650 PSIG and liquid side pressure of 150 PSIG.

2. Brazed plate heat exchangers shall be UL listed.

3. Exterior surfaces shall be covered with 1-1/2 inches of flexible, closed cell insulation, with a thermal conductivity of 0.26 ([BTU-Inch/HR-Ft² - degree F.]/Inch) maximum.

4. Water nozzles shall be provided with grooves for field provided ANSI/AWWA C-606 mechanical couplings.

5. Evaporator shall include vent and drain fittings and thermostatically controlled heaters to protect to -20 degrees F. ambient in off-cycle.

6. A 20-mesh, serviceable wye-strainer and mechanical couplings shall be provided for field installation on evaporator inlet prior to startup.

7. Evaporator shall be provided with piping extension kit and mechanical couplings to extend liquid connection from evaporator to edge of unit. Thermal dispersion type flow switch shall be factory installed in the evaporator outlet pipe extension and wired to the unit control panel. Insulation and heat trace on piping shall be responsibility of installing contractor. Extension kit nozzle connections shall be ANSI/AWWA C-606 (grooved).

E. Air Cooled Condenser:

1. Coils: Condenser coils shall be constructed of a single material to avoid galvanic corrosion due to dissimilar metals. Coils and headers are brazed as one piece. Integral sub cooling is included. Coils shall be designed for a design working pressure of 650 PSIG. Condenser coil shall be washable with potable water under 100 psi pressure.

2. Low Sound Fans: Shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise, full-airfoil cross section, providing vertical air discharge and low sound. Each fan shall be provided in an individual compartment to prevent cross flow during fan cycling. Guards of heavy gauge, PVC coated or galvanized steel shall be factory installed.

3. Fan Motors: High efficiency, direct drive, 6 pole, 3 phase, insulation class “F”, current protected, Totally Enclosed Air-Over (TEAO), rigid mounted, with double sealed, permanently lubricated, ball bearings.

F. Provide for each refrigerant circuit:

1. Discharge service ball type isolation valve.

2. High side pressure relief.

3. Liquid line shutoff valve with charging port.

4. Low side pressure relief device.

5. Filter-drier (replaceable core type).

6. Solenoid valve.

7. Sight glass with moisture indicator.

8. Electronic expansion valves.

9. Flexible, closed-cell foam insulated suction line and suction pressure transducer.

G. Electrical Power Connection and Distribution:

1. Equipment shall per listed per State of Alaska Requirements.

2. General:

a. Chiller main power electrical connection shall be a single point configuration. Provide single point disconnect and circuit breaker as indicated under Accessories and Options herein.
b. Chiller evaporator heaters and controls shall be a separate single point connection.

3. Power Panels:

a. NEMA 3R/12 rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors.
b. Power supply shall enter and terminate within unit at a single location.
c. Provide main power connection(s) (see schedule), 120VAC control power/heater connection(s), compressor and fan motor start contactors, current overloads, and factory wiring.

4. Electrical Rating:

a. Power, voltage, and phase as scheduled.
b. Controls and heater power 120VAC single phase.
c. Minimum of 20 kA Short Circuit Current Rating (SCCR).

5. Power Disconnect: Provide single point power connection as indicated under Accessories and Options herein.

6. Wire Distribution: Compressor, control and fan motor power wiring shall be located in an enclosed panel or routed through liquid tight conduit.

H. Controls:

1. Panels shall per listed per State of Alaska Requirements.

2. General:

a. Manufacturer shall provide controls necessary for automatic, stand-alone chiller operation.
b. Standard unit shall be capable of two operating modes (as a minimum):
1). Leaving Chilled Liquid Control: In this mode, unit stages compressors on/off to meet a leaving liquid temperature setpoint. Both the leaving liquid temperature setpoint and the dead band around the setpoint are adjustable and input by the User.
2). Return Chilled Liquid Control: In this mode, unit stages compressors on/off according to an internally calculated return liquid temperature schedule; cooling setpoint and range are adjustable and input by the User.

c. Contractor shall provide field control wiring as indicated on the drawings or necessary to interface external sensors to the chiller control system.

3. Unit Controls. Microprocessor based, with the following features:

    a. Automatic control of compressor start/stop, anti-coincidence and anti-recycle timers, automatic pump down at system shutdown, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, and chiller operation from 0 degrees F. to 125 degrees F. ambient. Automatic reset to normal chiller operation after power failure.
    b. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real-time-clock (RTC) memory for minimum 5 years.
    c. Forty character liquid crystal display, descriptions in English (or Spanish, French, Italian, or German), numeric data in English (or Metric) units. Sealed keypad with sections for Setpoints, Display/Print, Entry, Unit Options & clock, and On/Off Switch.
    d. Programmable Setpoints (within Manufacturer limits): Display language; chilled liquid temperature setpoint and range, remote reset temperature range, daily schedule/holiday for start/stop, manual override for servicing, low and high ambient cutouts, low liquid temperature cutout, low suction pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anti-coincident timer (delay compressor starts).
    e. Display Data: Return and leaving liquid temperatures, low leaving liquid temperature cutout setting, low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure, liquid temperature reset via a 4-20milliamp or 0-10 VDC input, anti-recycle timer status for each compressor, anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system lead/lag control, lead system definition, compressor starts/operating hours (each), status of hot gas valves, evaporator heater and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load and unload timer status, water pump status.
    f. System Safeties: Shall cause individual compressor systems to perform auto shut down; manual reset required after the third trip in 90 minutes. System safeties include: high discharge pressure, low suction pressure, high pressure switch, and motor protector. Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.
    g. Unit Safeties: Shall be automatic reset and cause compressors to shut down if low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation.
    h. Alarm Contacts: Low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure, and low suction pressure.
    i. BAS Communications: As a minimum, provide with BACnet MS/TP communication capability for future connection to renovated BAS system.

4. Building Automation System (BAS) Interface Controls: See 255000 – Building Automation System.

I. ACCESSORIES AND OPTIONS

1. The following accessories and options supersede standard product features listed above. Provide:

a. Extended Compressor Warranty: Three year parts only warranty for compressors.
b. Compressor Starters: Microprocessor controlled, adjustable, factory installed soft-start type starters for compressor motors
c. Refrigeration System Isolation Valves: Suction side isolation valves for each compressor (discharge service valves are standard).
d. Power Supply Connections:
    1). Single Point Disconnect: Single Non-Fused Disconnect(s) and lockable external handle (in compliance with Article 440-14 of N.E.C.) supplied to isolate the unit power voltage for servicing.
    2). Provide single point circuit breaker rated for the minimum SCWR.

e. Low Ambient Control Kit:
    1). Provide all necessary components to permit chiller operation to 0 degrees F.
    2). Include, but not limited to, discharge pressure transducer/readout capability.

f. Condenser Coil Environmental Protection: Dipped-cured coating on condenser coils for seashore and other corrosive applications.
g. Protective Chiller Panels:
    1). Factory Mounted Louvered/Wire Panels: Louvered steel panels on external condenser coils painted to match remainder of unit cabinet.
    2). Heavy gauge, welded wire-mesh, coated to resist corrosion, around base of machine to restrict unauthorized access.

h. Thermal Dispersion Flow Switch:
    1). Factory installed and wired into piping extension kit.
    2). Normally open, 30 bar pressure rating, stainless steel 316L construction, IP67, -4 degrees F. to 158 degrees F. ambient rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Rig and Install in full accordance with Manufacturer's requirements, Project drawings, and Contract documents.

B. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure.

C. Components: Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.

D. Electrical: Coordinate electrical requirements and connections for all power feeds with Electrical Contractor (Divisions 26, 27 and 28).

E. Finish: Installing Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory finish.

F. Controls: Coordinate unit and system control requirements with section 255000 - Building Automation System.

3.2 UNIT OPERATING MODES (SEQUENCE OF OPERATIONS)

A. Provide standard operational programming as recommended by unit Manufacturer.

B. For both units, implement standard internal control modes or options as follows (see Manufacturer's IOM manual):

1. "Return Chilled Liquid Control" mode as described in the latest edition of the Installation, Operation, And Maintenance (IOM) manual.

a. Cooling Setpoint = 42 degrees F.
b. Range = 10 degrees F.

2. "Return Chilled Liquid System Lead/Lag and Compressor Sequencing" mode to help equalize average run hours between systems.

3. "Anti-Recycle Timer" to assure the systems do not cycle. Coordinate cycle timer setting (between 300 and 600 seconds) with Manufacturer's recommendation and Owner's requirements.

4. "Anti-Coincident Timer" to assure compressors within a circuit or system do not start simultaneously.

3.3 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Verify that the units are installed and operational in accordance with the manufacturer's written installation instructions.

2. Both the Contractor and Manufacturer's Representative(s) shall sign start-up and operational checklist to confirm proper system installation and operation.

3.5 CLEANING

A. Upon completion of installation and prior to initial start-up, clean internal and external surfaces.

3.6 DEMONSTRATION & START-UP

A. Provide two Demonstration and Start-up visits to site in Yakutat, AK:

1. First on-site visit to coincide with initial start-up of units after completion of installation. Upon completion of this site visit, unit installations and Test and Balance shall be complete, and chilled water system 100 percent functional and ready for Owner's acceptance and use. After demonstration and Owner training, Contractor shall coordinate with Owner for seasonal shutdown of units and system.

2. Second on-site visit: Contractor shall coordinate with Owner for seasonal wake-up of units and system. Unit start-up checklist items shall be reviewed and tested for conformity with initial start-up procedures.

B. Start-up and operate chilled water unit in accordance with the manufacturer's written installation and operation and maintenance.

C. Verify operating sequence in accordance with above.

D. Document start-up and operational checks using the manufacturer's installation checklist and submit in accordance with submittal requirements.

3.7 TRAINING

A. Instruct Owner's Representatives for four hours with regard to:

1. System start-up.

2. Normal system operation.

3. System shut-down.

4. Packaged control system programming and interfaces.

5. Preventative maintenance.

END OF SECTION 236400

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 237323 - CENTRAL AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Central air handling units.
2. Air filter media and support frames.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200548 - Mechanical Vibration and Seismic Control
5. 200553 - Mechanical Identification
6. 200700 - Mechanical Insulation
7. 230593 - Testing, Adjusting and Balancing
8. 232113 - Hydronic Piping and Specialties
9. 233100 - Ducts and Accessories
10. 253000 - Building Automation System Field Devices
11. 254000 - Variable Speed Drives
12. 255000 - Building Automation System
13. 259000 - Sequence of Operations
14. Divisions 26, 27 and 28 - Electrical

1.2 REFERENCES

A. Codes and Standards:

1. International Mechanical Code (IMC).

2. AMCA 99 - Standards Handbook.

3. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

4. ASHRAE Standard 52.1-1992 - Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

5. ASHRAE Standard 52.2-2012 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.

2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.

3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. This section describes specific requirements, products and methods of execution for the central air handling equipment, which will be distributed to the locations shown.

2. The method of air distribution is specified elsewhere.

B. Performance Requirements:

1. Provide product performance characteristics as specified or scheduled on drawings.

2. Operate ventilation systems in accordance with Section 259000 - Sequence of Operations.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate and sequence installation of air handling units with trades responsible for portions of this and other related sections of the Project Manual prior to installation of air handling units.

1.5 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Sound Power Levels: Provide custom sound power level data (decibels) for each octave band at inlet, discharge and radiated for the assembled air handling unit as shown.

a. Octave band sound power levels shall not exceed those scheduled.
b. Determine sound level data using one of the following methods:
   1). Actual measurements from tests performed in accordance with AMCA Standards in an AMCA registered test chamber.
   2). Documented calculations that start with AMCA tested fan sound data and are modified in accordance with ASHRAE Handbook 2011 HVAC Applications, Chapter 48 - Noise and Vibration Control to accurately predict the sound power levels for the configuration shown.

2. Wiring Diagrams: Provide electrical power connection and control logic wiring diagrams. Diagrams must differentiate between factory installed and field-installed wiring.

C. Shop Drawings:

1. This Section shop drawings to be submitted under Section 200000 - Mechanical General Requirements.

2. Provide dimensional and orientation information (plan and elevation) for the approved central air handling unit(s), including housekeeping pad perimeter, incorporated into the ventilation system shop drawings.

   a. Label overall air handling unit(s) as scheduled. Label each cabinet section as specified.
   b. Show duct connections, with duct sizes indicated. Locate bottom of supply duct connections off discharge plenum as high as possible to maximize fan room floor space.
   c. Show damper arrangement and sizes.
   d. Show access door locations and access clearances for filter, coil and fan replacement.
   e. Show electrical connection points.

3. Coordinate supply fan discharge plenum floor penetrations and return fan/exhaust fan roof penetrations with structural. Exhaust fan vertical stack/relief hood alignment is critical as is coil/filter pull space alignment with the buildings support columns.

D. Installation, Operation and Maintenance (IO&M) Manuals.

E. Manufacturer Reports:

1. Provide a certificate from the Manufacturer's Representative indicating that the central air handling unit(s) is/are installed and operational in accordance with the manufacturer’s written installation, operation and maintenance manual.

2. Provide start-up and operational checks using manufacturer checklists, signed by both the installing Contractor and Manufacturer’s Representatives.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Warranty Documentation: Provide standard manufacturer's warranty and submit documentation in accordance with Section 200000.

C. Record Documentation.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials (Spare Filters):

1. Furnish one complete set of replacement filters for each air handling unit upon final completion of project.

2. Filters are to remain sealed in their original boxes and labeled by equipment tag as scheduled. Locate filters in storage area designated by the Contracting Agency.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Minimum ten years of documented experience manufacturing the products specified.

2. Installers: Minimum five years of experience in the installation and start-up of products specified.

B. Certifications: Air filters must be certified and tested in accordance with ASHRAE Test Standard 52.1.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 200000 - Mechanical General Requirements for general delivery, storage and handling requirements.

B. Delivery and Acceptance Requirements:

1. Factory shrink wrap entire unit with minimum 10 mil poly for shipping protection.

2. Provide blocking to protect protruding elements from damage.

C. Storage and Handling Requirements: Maintain access doors shut, dampers and supply duct connections covered, and drain connections capped to protect components from construction dirt and debris.

1.10 WARRANTY

A. See Section 200000 - Mechanical General Requirements for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 CENTRAL AIR HANDLING UNITS

A. Manufacturers:

1. Haakon.

2. Energy Labs, Inc.

3. Huntair.

4. Trane.

5. Substitution request required.

B. Description:

1. Dimensions: Air handler dimensions and base rail heights scheduled are for basis of design manufacturer as indicated. The dimensions for “as equal” manufacturers may differ. Prior to submitting equipment provided by an “as equal” manufacturer, verify that the unit will adequately fit in the space provided with proper access for operation and maintenance to include the removal/replacement of components.

2. Regulatory Requirements: Products requiring electrical connection - Listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the Authority Having Jurisdiction.

C. Unit casing construction:

1. Welded structural steel channel base frame with lifting and anchoring lugs.

2. Minimum 16 gauge galvanized steel cabinet, reinforced and braced with steel angle framing for maximum rigidity.

3. Acoustically lined cabinet interior with 4-inch thick, 3 lb/cu ft, UL listed acoustical liner materials.

4. Exterior casing, base frame and accessories coated with baked enamel finish.

5. Internal components and accessories coated with baked enamel finish or galvanized.

6. Connect parts with plated, galvanized steel fasteners.

7. Provide interior liner type and drain pan as indicated under each air handler section.

8. Provide steel stamped nameplate with air handler performance data clearly indicated.

9. Provide 12 gauge galvanized steel, continuously welded checker plate floor with a maximum deflection of 1/4 inch in a 240 inch span. Units that "oil can" are not acceptable.

10. Insulate base with a minimum 2-inch fiberglass insulation and sheet it with 22 gauge galvanized steel liner.

11. Provide watertight wash down floor construction with 1.5-inch water dam around the perimeter of the floor.

12. The use of metal tape in the unit construction is not acceptable.

13. Provide insulated access doors with windows and to match casing thickness. Minimum access door width is 24 inches.

14. Provide maintenance and access plenums for each bank of filters and each coil section. Provide each plenum section with an access door. Do not "gang" together pre- and final filters, or heating and cooling coils.

15. Provide shipping splits such that no individual section is longer than 120 inches.

D. Mixing box Section:

1. 22 gauge solid galvanized steel interior liner.

2. Hinged, insulated, double walled access door.

3. Provide floor drain with capped drain connection that terminates through side of unit.

4. IAQ Control Damper/Monitor:

   a. Manufacturer: Tamco, Series 9000. No substitutes.
   b. Low leakage, heavy gauge, internally insulated, extruded aluminum, air foil blades with extruded EDPM blade gaskets and frame seals.
   c. Flanged frame with parallel blade action.
   d. Damper Sizing: Provide IAQ damper for the AHU minimum outside air flow rate (CFM) scheduled using a flow velocity of 1,500 FPM not to exceed 0.1-inch static pressure drop with damper fully open.
   e. Damper mounting.
      1). Mount IAQ damper to economizer cooling damper forming an integral rectangular damper assembly.
      2). Mount the damper assembly to the mixing box as indicated.

5. Economizer Cooling and Exhaust Air Control Dampers:

   a. Manufacturer: Tamco, Series 9000. No substitutes.
   b. Performance/Design Criteria:
      1). Leakage Class 1A at 1 inch W.C. static pressure differential.
      2). Designed for operation in temperatures ranging between -40 degrees F. and 212 degrees F.
      3). Size dampers using a flow velocity range of 1,250 to 1,500 FPM not to exceed 0.1-inch static pressure drop with damper fully open.
      4). Size economizer cooling damper for maximum AHU air flow rate (CFM) scheduled minus the minimum outside air flow rate (CFM) scheduled.

5). Size exhaust air damper for maximum AHU air flow rate (CFM) scheduled minus the minimum outside air flow rate (CFM) scheduled.

c. Materials:
1). Heavy gauge, extruded aluminum frame and blades.
2). Internally insulated, air foil blades with extruded EDPM blade seals
3). Extruded silicone frame seals.
4). Flanged frame with parallel blade action.

6. Return Air Control Dampers:

a. Manufacturer: Tamco, series 1000 or approved equal.
b. Performance/Design Criteria:
1). Leakage Class 1A at 1 inch W.C. static pressure differential.
2). Designed for operation in temperatures ranging between -40 degrees F. and 212 degrees F.
3). Size dampers using a flow velocity range of 1,250 to 1,500 FPM not to exceed 0.1-inch static pressure drop with damper fully open.
4). Size return air damper for maximum AHU air flow rate (CFM) scheduled.

c. Materials:
1). Heavy gauge, extruded aluminum frame and blades.
2). Air foil blades with extruded EDPM blade seals.
3). Extruded silicone frame seals.
4). Flanged frame with parallel blade action.

7. Damper Arrangement:

a. Provide dampers, factory installed and sealed to the cabinet as indicated.
b. Provide IAQ and economizer cooling dampers combined into an integral rectangular unit horizontally centered on top of mixing box with IAQ damper located upstream of economizer cooling damper. Locate IAQ damper frame a maximum of one foot from the front interior wall of mixing box section. Provide mounting flange for attachment of outside air intake ductwork. Arrange parallel dampers to direct outside air upstream towards return air damper to promote mixing.
c. Provide return air damper horizontally centered on front of mixing box. Locate top of return damper a maximum of one foot from top of mixing box interior ceiling. Arrange parallel dampers to direct return air up towards combination IAQ/economizer cooling damper to promote mixing.

E. Filter Sections:

1. Cabinet:

a. 22 gauge solid galvanized steel interior liner.
b. Hinged, insulated, double walled access door.
c. Provide floor drain with capped drain connection that terminates through side of unit.

2. Manufacturers:

a. Camfil Farr.
b. American Air Filter.
c. Flanders.
d. Substitution request required.

3. Filter Holding Frame:

a. Factory installed filter housing and frame designed specifically for the specified filters.
   1). Welded, galvanized steel reinforced with bracing and corner gussets and sealed to prevent leakage.
   2). Gaskets in filter frames of closed cell synthetic rubber and positive spring type clamps to hold filter securely against gaskets.
   3). Access for changing filters from one or both sides of housing. Walk-in plenums shall have access for changing filter from upstream side.
   4). Side access filter units consisting of a separate frame for each filter, sliding on tracks with a gasket system, shall be provided where indicated. Standard manufactured systems shall be used.

b. Provide detail for filter holding frames, grids and filter housing arrangements as applicable. Indicate filter sizes and number of each filter size necessary to complete each filter bank, using 24-inch x 24-inch filter dimensions whenever possible.

4. Pre-filters:

a. Provide disposable, pleated dry media filters having an average efficiency of 25 percent to 30 percent when tested in accordance with ASHRAE 52.1 with an average arrestance of 90 percent to 92 percent. Filters shall have a Minimum Efficiency Reporting Value of MERV 8 or greater when tested in accordance with ASHRAE 52.2.
b. Complete filter shall be UL listed as a Class 2 air filter.
c. Filter shall be constructed from pleated media supported and bonded to welded wire grid within a rigid beverage board frame. Media shall be non-woven, reinforced cotton and synthetic fabric. Media shall provide not less than 4.5 square feet of media area for each square foot of face area. Media and frame shall be bonded to prevent air leakage.
d. Design of filter bank shall be based on an airflow rate of not more than 350 CFM per square foot of gross face area unless otherwise indicated. Initial static pressure loss shall not exceed 0.31 inches water column at 500 feet per minute face velocity. Filters shall be capable of operating at up to 1.0 inch W.C. at 500 fpm face velocity.
e. Preferred filter sizes are 24 by 24 by 2 inches with maximum of one 24 by 12 by 2 inches per row. Filter banks shall be designed to use the minimum number of readily available standard filter sizes.

5. Final Filters:

a. Provide high performance, preformed, deep pleated, disposable type dry media filters having an average efficiency of 90 to 95 percent when tested in accordance with ASHRAE 52.1-1992 and an average arrestance of not less than 99 percent. Filters shall have a Minimum Efficiency Reporting Value of MERV 14 or greater when tested in accordance with ASHRAE 52.2.

b. Non-woven polypropylene microfiber filter media. Effective media area not less than 41 square feet of filter area for 24 inch by 24 inch by 12 inch filter size.
c. Welded steel, PVC coated media retainer to prevent oscillation and sagging of media.
d. Size filter bank for medium airflow capacity (300 FPM). Initial static pressure not to exceed 0.24 inches W.C. at 300 feet per minute face velocity. Filter shall be designed to operate at up to 1.0 inches water column (manufacturer's recommended final resistance).
e. Preferred filter sizes are 24 by 24 by 2 inches with maximum of one 24 by 12 by 2 inches per row. Filter banks shall be designed to use the minimum number of readily available standard filter sizes.

6. Filter Gauges:

a. Manufacturers: Magna-helic (Basis of Design) or approved equal.
b. Provide a dial type gauge with diaphragm magnetically coupled to pointer and with connections to upstream and downstream static pressure probes for each filter bank.
c. Provide monitoring contacts for connection to the BAS. Coordinate with 255000 - Building Automation System and Section 259000 - Sequence of Operations to connect filter monitoring pressure switches to same probes as the gauge.
d. Gauge scale range shall be 0 to 1 inch W.C. for pre-filters and 0 to 2 inch W.C. for final filters.

F. Heating Coil Section:

1. Performance/Design Criteria:

a. Coil performance as scheduled.
b. Coils designed for counter-flow heat transfer with equal pressure drop through each circuit.
c. Working Pressure: 250 PSIG.

2. Cabinet:

a. 22 gauge solid galvanized steel interior liner.
b. Sloped, galvanized steel drain pan with capped drain connection that terminates through side of unit.
c. Provide split casing panel to facilitate coil removal. Coordinate panel location with coil access and coil piping.

3. Heating Coil:

a. Primary surface:
1). Round, seamless, 5/8 inch O.D. x 0.025 inch thick copper tubing.
2). Tubes mechanically expanded into fins over the entire finned length.
3). Brazed joints.

b. Secondary surface: Solid, 0.0095 inch thick aluminum fins (no punched openings to accumulate lint and dirt) with full drawn collars (Bare copper tube not visible between fins).

c. Coil Casing: Continuous 16 gauge galvanized steel with reinforced flange type side plates.
d. Coil piping connections:
   1). Male Pipe Thread (MPT) connections for 2-inch and smaller pipe.
   2). Flange connections for 2-1/2 inch and larger pipe.
   3). Cap piping connections prior to shipment.
   4). For staggered coils, extend coil piping connections to outside of casing.

e. Coil Headers:
   1). Seamless, copper tubing.
   2). Low point coil drain and high point coil vent.

G. Cooling Coil Section:

1. Performance/Design Criteria:

   a. Coil performance as scheduled.
   b. Coils designed for counter-flow heat transfer with equal pressure drop through each circuit.
   c. Working Pressure: 250 PSIG.

2. Cabinet:

   a. 22 gauge solid galvanized steel interior liner.
   b. Hinged, insulated, double walled access door with window.
   c. 16 gauge stainless steel, double-sloped insulated drain pan with capped drain connection that terminates through side of unit. 16 gauge stainless steel intermediate drain pans on units with stacked coils.
   d. Provide split casing panel to facilitate coil removal. Coordinate panel location with coil access and coil piping.

3. Chilled Water Cooling Coil:

   a. Primary surface:
      1). Round, seamless, 5/8 inch O.D. x 0.025 inch thick copper tubing.
      2). Tubes mechanically expanded into fins over the entire finned length.
      3). Brazed joints.

   b. Secondary surface: Solid, 0.0095 inch thick aluminum fins (no punched openings to accumulate lint and dirt) with full drawn collars (bare copper tube not visible between fins).
   c. Coil Casing: Continuous, 16 gauge stainless steel with reinforced flange type side plates.
   d. Coil piping connections:
      1). Male Pipe Thread (MPT) connections for 2-inch and smaller pipe.
      2). Flange connections for 2-1/2 inch and larger pipe.
      3). Cap piping connections prior to shipment.
      4). For staggered coils, extend coil piping connections to outside of casing.

   e. Coil Headers:
      1). Seamless, copper tubing.

2). Low point coil drain and high point coil vent.

H. Fan Section:

1. Cabinet:

a. 22 gauge perforated, galvanized steel interior liner.
b. Hinged, insulated, double walled access door.
c. Provide floor drain with capped drain connection that terminates through side of unit.

2. Fan Manufacturers:

a. Haakon.
b. Twin City.
c. Greenheck.
d. Cook.
e. Barry Blower.
f. Energy Labs.

3. General Fan Requirements:

a. Provide factory assembled, balanced and tested fan unit of the size, type and capacity scheduled. AMCA listed and labeled.
b. Provide factory applied enamel coating system to fan assembly components (except aluminum).
c. Provide fan arrangement with accessibility for complete cleaning, component replacement and preventative maintenance. Provide grease fitting(s) with extended grease lines (as necessary for direct access).
d. Provide AMCA approved fan wheel guard.

4. Vibration Isolation:

a. Isolate fan frame from unit casing using stable spring vibration isolators with a 2-inch minimum static deflection.
1). Manufacturer: Mason Industries model SSLFH, VMC Group, or equal.

b. Isolate fan vibration from inlet nozzle with flexible airtight joint:
1). UL Listed, vinyl coated, woven nylon/polyester blend fabric with double folded seam and galvanized steel edging.
2). Manufacturer: Duro-dyne Corporation, Vent Fabrics, or equal.

c. Bearings: Greater than 200,000 hours average rated life at rated load and speed specified.

5. Belt Drive Fans:

a. Provide V-belt drive for each fan selected for not less than 1.5 times the motor nameplate horsepower. Light duty belts (FHP) acceptable only with motors less than one horsepower. Sheaves shall be cast iron or steel.

b. Ten HP and smaller: Provide adjustable pitch drive sheave. Field adjust drive sheave and fan/pulley combination as necessary to attain required fan performance with drive adjusted to near mid-span.
c. Larger than Ten HP: Provide fixed speed drive sheave. Change fan and drive sheave in the field as necessary to attain required fan performance.
d. Provide OSHA belt guard with hinged tachometer cap.

6. Motors: See Section 200513 - Common Motor Requirements, for detailed fan motor specifications.

7. Fan Curve(s): Provide fully labeled fan curve(s) with system curve and operating point clearly plotted. For variable speed fans, provide fan curves for both minimum and maximum operating points.

8. Air flow Monitoring Stations:

a. Manufacturer.
1). Air Monitor Corporation, model Volu-Probe/FI.
2). Approved equal.

b. Multi-port, self-averaging airflow probes with integral airflow direction correcting design.
c. Provide separate factory mounted airflow monitoring station each fan.
d. Mount velocity probes directly to fan inlet cone or bell-mouth.
e. Accuracy: Three percent.

I. Discharge Plenum Section:

1. Provide custom discharge plenums for air handling units. Fabricate custom discharge plenums to the same material, fabrication and quality standards as other cabinet sections.

2. 22 gauge perforated galvanized steel interior liner.

3. Hinged, insulated, double walled access door.

4. Provide external bell mouth fitting at each supply air duct connection to discharge plenums. Show dimensioned bell mouth locations on equipment submittals.

J. Electrical Requirements:

1. Power requirements as scheduled.

2. Provide marine lights with a protective metal cage and glass seals, complete with duplex receptacle, on wall opposite each access door.

3. Provide single pilot light-type light switch on exterior of unit to activate lights.

4. Provide separate power circuits for fan motors and 120VAC lighting/receptacle power.

5. Provide a single empty 3/4 inch conduit installed internally to the unit with an internal J-box in each section for future (field installed) controls. Terminate empty control conduit on the exterior of the unit in a single J-box.

PART 3 - EXECUTION

3.1 INSTALLERS

A. Installer: Perform work by experienced personnel previously engaged in ventilation system construction and air handling unit installation, and under the supervision of a qualified installation supervisor.

3.2 PREPARATION

A. Protection of In-Place Conditions:

1. Provide a complete set of pre-filters for use during construction. Final filter bank media is to remain sealed in original boxes until final building housekeeping has been completed.

2. Protect return air inlet with 30 percent filters during construction.

B. Surface Preparation: Provide clean and level housekeeping pad to support equipment.

3.3 INSTALLATION

A. General:

1. Install air handling units and components in compliance with the manufacturer’s written installation instructions. Rework required as a result of failure to follow the manufacturer’s written installation instructions or to properly coordinate with Other Work shall be completed at no additional expense to the Contracting Agency.

2. Locate hydronic piping connections and drip pan drains on same side of unit(s) as floor drain.

3. Provide field installed condensate traps per manufacturer's recommendations on cooling coil drains. Pipe to indirect drain to floor drain.

4. Support central air handling unit base frames on concrete housekeeping pads. Center units on housekeeping pads to provide an equal housekeeping pad lip all around unit.

B. Interface with Other Work:

1. Seismically anchor air handling unit(s) using method approved by the seismic design engineer and in accordance with Section 200548 - Mechanical Vibration and Seismic Control.

2. Install hydronic heating and cooling piping in accordance with Section 232113 - Hydronic Piping and Specialties.

3. Install ductwork in accordance with Section 233100 - Ducts and Accessories.

4. Install BAS actuators, sensors, controls and control wiring in accordance with Section 255000 - Building Automation System.

5. Install electrical power and wiring in accordance with Divisions 26, 27 and 28.

3.4 REPAIR/RESTORATION

A. Refer to Section 200000 - Mechanical General Requirements for general repair/restoration requirements.

3.5 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. With ventilation system operating at maximum air volume flow rate and with clean filter media installed:

a. Verify each filter bank is properly sealed and filter bank leakage is within manufacturer’s performance tolerances.
b. Verify that filter bank differential pressure gauges are operating properly in accordance with manufacturer’s written installation, operation and maintenance instructions.
c. Verify that clean filter differential pressures are as indicated in manufacturer’s submittal data (within 5 percent) for actual filter bank flow velocity.

B. Manufacturer Services: Verify air handling unit(s) is/are installed and operational in accordance with the manufacturer’s written installation instructions.

3.6 SYSTEM START-UP

A. Start-up and operate air handling units in accordance with the manufacturer’s written installation, operation and maintenance (IO&M) manual.

B. Verify proper operation in accordance with Section 259000 - Sequence of Operations.

C. Document start-up and operational checks using manufacturer checklists and submit in accordance with submittal requirements.

3.7 ADJUSTING

A. Test, adjust and balance air handling equipment in accordance with Section 230593 - Testing, Adjusting and Balancing, the manufacturer's recommendations and as otherwise directed by the Contracting Agency.

3.8 CLEANING

A. Upon completion of installation and prior to initial start-up, vacuum and wipe down internal and external surfaces.

B. Upon completion of final housekeeping and with written approval of the Contracting Agency, replace construction pre-filters with a complete set of new pre-filters and install remaining filter banks for use during testing and balancing.

END OF SECTION 237323

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 238123 - DEDICATED AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Packaged, direct expansion, air conditioning systems with microprocessor based controls for electrical room cooling.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200548 - Mechanical Vibration and Seismic Control
4. 221100 - Domestic Water Piping and Specialties
5. 221300 - Sanitary Waste and Vent Piping and Specialties
6. 259000 - Sequence of Operations

1.2 SUBMITTALS

A. Product Data: Submit copies of product data indicating rated capacities, weights, accessories, and electrical requirements.

B. Shop Drawings: Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location, routing and size of refrigerant lines and condenser discharge ductwork.

C. Closeout Submittals: Submit copies of operation and maintenance manuals in accordance with Section 200000 - Mechanical General Requirements.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Units shall be UL listed.

1.4 DELIVERY, STORAGE AND HANDLING

A. Acceptance at Site:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Protection:

1. Outside the general construction zone, store products in covered storage area protected from the elements until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.5 WARRANTY

A. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

PART 2 - PRODUCTS

2.1 SELF CONTAINED AIR CONDITIONING UNIT (AC-1)

A. General:
1. Provide packaged, direct expansion, self-contained air conditioning system as scheduled. System consists of wall mounted evaporator unit with fan motor and a separate, remote, mounted condenser unit with variable speed inverter driven compressor. System refrigerant shall be R-410A. The system shall maintain zone setpoint temperatures using a packaged microprocessor based programmable temperature control system.
2. Basis of Design: Mitsubishi.

B. Indoor Unit:
1. The indoor unit shall be factory assembled and tested complete with factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The discharge angle shall automatically set at the same angle as the previous operation upon restart.
2. Indoor unit and refrigerant pipes shall be charged with dehydrated air prior to shipment from the factory.
3. Cabinet:
   a. The cabinet shall be fixed to factory supplied wall hanging brackets.
4. Fans and Motors:
   a. The fan shall be direct-drive cross flow fan type with statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on voltage as scheduled on the drawings.
   c. Fan shall include a manually adjustable guide vane to adjust airflow from side-to-side.
5. Filter: Removable, washable filter.
6. Evaporator Coil:

a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
b. The coil shall be completely factory tested.

7. Electrical:
   a. The fan motor shall operate on voltage as scheduled on the drawings.
   b. Power for the indoor unit shall be supplied from the outdoor unit.
8. Controls:
   a. Microprocessor Control:
      1). The unit shall be controlled by a stand-alone microprocessor-based control system located in the indoor unit.
      2). Provide optional hard wired “in-room” remote sensor kit.

C. Remote Condensing Unit:
1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a rotary compressor, motors, fan, condenser coil, electronic expansion valves, solenoid valves, distribution headers, capillaries, filters, shut off valves, service ports and suction accumulator.
2. The system will automatically restart operation after a power failure and will not cause any settings to be lost, eliminating the need for re-programming.
3. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a thermally fused acrylic or polyester powder coating finish.
4. Fans and Motors:
   a. The condensing unit fan shall consist of one propeller type, direct-drive motor that has multiple speed operation via a DC (digitally commutating) inverter.
   b. The fan shall be a horizontal discharge configuration with a nominal airflow maximum of 1,590 cfm.
   c. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
   d. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
5. Condenser Coil:
   a. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
6. Compressor:
   a. The rotary compressor shall be variable speed controlled and capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit.
   b. The inverter driven compressor shall be a reluctance DC (digitally commutating), twin-rotor rotary type.
   c. A minimal amount of current shall be automatically, intermittently applied to compressor motor windings to maintain sufficient heat to vaporize refrigerant. No crankcase heater to be provided.
   d. The compressor shall be equipped with high pressure safety switch and internal thermal overload protector.
   e. The compressor shall be mounted to avoid the transmission of vibration.

D. Quality Assurance:

1. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 - Heating and Cooling Equipment and bear the Listed Mark.
2. Wiring shall be in accordance with the National Electric Code (NEC).
3. System rated in accordance with Air Conditioning Refrigeration Institute's (ARI) Standard 210/240 and bear the ARI label.
4. Provide a holding charge of dry nitrogen in the evaporator.
5. System efficiency meets or exceeds 17.6 SEER.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install units in accordance with manufacturer's written installation instructions.

2. Install units plumb and level, firmly anchored in the locations indicated while maintaining manufacturer's recommended clearances.

B. Electrical Wiring: Furnish one copy of manufacturer's electrical connection diagrams to the electrical subcontractor.

C. Piping Connections: Furnish one copy of manufacturer's condensate pump connection diagram to the plumbing subcontractor.

3.2 FIELD QUALITY CONTROL

A. Startup air conditioning unit in accordance with the manufacturer's written start up instructions.

B. Test control features and demonstrate compliance with operational requirements.

END OF SECTION 238123

SECTION 238200 - TERMINAL HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinet unit heaters.
2. Unit heaters.
3. Fintube radiation.
4. Radiant ceiling panels.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200529 - Mechanical Hangers and Supports
5. 200548 - Mechanical Vibration and Seismic Control
6. 200553 - Mechanical Identification
7. 200700 - Mechanical Insulation
8. 230593 - Testing, Adjusting and Balancing
9. 232113 - Hydronic Piping and Specialties
10. 233100 - Ducts and Accessories
11. 233600 - Air Terminal Units
12. 233700 - Air Outlets and Inlets
13. 253000 - Building Automation System Field Devices
14. 255000 - Building Automation System
15. 259000 - Sequence of Operations

1.2 REFERENCES

A. International Mechanical Code (IMC).

B. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Provide terminal heating and cooling units, piping, appurtenances, and controls to automatically maintain interior temperature setpoint for each area of the building.

B. Performance Requirements: Provide performance and output shown or scheduled on drawings.

1.4 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements.

B. Product Data:

1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.

2. Include the following:

a. Performance characteristics as scheduled.
b. Enclosure style, material and grille arrangement.
c. Dimensional data.

C. Shop Drawings:

1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

2. Indicate mechanical and electrical service locations and requirements.

D. Samples:

1. Provide color samples of fintube and cabinet unit heater enclosures.

2. Colors to be selected by the Contracting Agency.

E. Provide certificates, manufacturer’s instructions, and manufacturer’s field reports for Quality Assurance/Control Submittals:

1. Provide a complete manufacturer’s written installation, operation and maintenance manual for each type of installed equipment.

2. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.

3. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:

   a. Printed names and signatures of the installers.
   b. Documentation from Manufacturer's representative and Contracting Agency that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.

F. Closeout Submittals:

1. Project Record Documents: Record actual locations of components and locations of access doors in terminal unit cabinets required for access or valves.

2. Operation and Maintenance (IO&M) Manuals:

   a. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
   b. Provide copies of approved submittal information for inclusion within the project IO&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list.

1.5 QUALITY ASSURANCE

A. Manufacturer qualifications: Company specializing in manufacturing the products specified in this section with a minimum of three years documented experience.

B. Installers' qualifications: Minimum three years experience in the installation and start-up of packaged central air handling systems.

C. Pre-Installation Meetings: Coordinate installation of terminal heating and cooling units with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any terminal heating and cooling unit components.

D. Regulatory requirements: Products requiring electrical connection - Listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the Authority Having Jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Protection:

1. Outside the general construction zone, store products in covered storage area protected from the elements, until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

C. Extra Materials: Provide one set replacement filters for cabinet unit heaters.

1.7 WARRANTY

A. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

B. Provide five year manufacturer's warranty for unit heaters and cabinet unit heaters.

C. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.

D. Provide to the Contracting Agency one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

PART 2 - PRODUCTS

2.1 FINTUBE RADIATION

A. Description: Radiation heating terminal units consisting of continuous finned tubing with or without metal enclosure.

B. Heating Elements:

1. Seamless copper tubing suitable for soldered fittings (as scheduled).

2. Mechanically expanded, evenly spaced aluminum fins (as scheduled).

C. Element Hangers: Elements shall be supported by sliding or rolling brackets designed to provide for unrestricted longitudinal movement and noiseless expansion. Hangers from the upper portion of the back panel which shall be of sufficient length to accommodate expansion and contraction of the element without distortion of the fins. Hangers shall be designed to support the element clear of all portions of the enclosure and shall not depend upon any frictional device for attachment. Hangers are not applicable to more than one element tier. Provide an approved expansion compensator for each 20 feet or greater of element including bare pipe connections.

D. Enclosures: Configuration and dimensions as scheduled and to include:

1. Minimum metal thickness: 14 gauge.

2. Full back panel with vertical stiffeners and elements supports.

3. Lower edge of enclosure braced to element supports and/or back panel.

4. Concealed tongue and groove type stiffener joints between enclosure sections.

5. Wall to wall enclosure or end covers as shown.

6. Support cabinet rigidly to wall or on floor mounted brackets at three feet on center maximum spacing.

E. Finish: Factory applied baked enamel finish. Colors to be selected by the Contracting Agency.

F. Access Doors: For otherwise inaccessible valves, provide factory made permanently hinged access doors integral with cabinet.

G. Rated heat output shall be determined in accordance with I-B-R procedures. Unless otherwise stated, the heat output requirements listed in the Schedule are standard catalog ratings for hot water at a tube velocity of three feet per second. Corrections for velocity and glycol solutions have been included in calculations to determine element length and flow volume.

H. Capacity: As scheduled.

I. Manufacturers: Sterling, Modine, Rittling, Trane, Vulcan, Slant fin.

2.2 UNIT HEATERS

A. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

B. Casing: 0.0478-inch steel with threaded pipe connections for hanger rods.

C. Finish: Factory applied baked enamel finish.

D. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

E. Air Outlet: Adjustable pattern diffuser on projection models and two way louvers on horizontal throw models.

F. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Section 200513 - Common Motor Requirements.

G. Control: Local disconnect switch.

H. Capacity: As scheduled.

I. Electrical Characteristics:

1. Horsepower, voltage, and phase as scheduled on the Drawings, 60 Hz.

2. Refer to Divisions 26, 27 and 28.

J. Manufacturers: Modine, Sterling, Rittling, Trane, Vulcan.

2.3 CABINET UNIT HEATERS

A. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes designed for 100 psi and 220 degrees F.

B. Cabinet: 0.0598-inch steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, and integral air outlet and integral air outlet and inlet grilles.

C. Finish: Factory applied baked enamel finish. Colors to be selected by the Contracting Agency.

D. Fans: Centrifugal forward curved, double width wheels, statically and dynamically balanced, direct driven.

E. Motor: three-speed, tap wound permanent split capacitor, with sleeve bearings, resiliently mounted. Refer to Section 200513 - Common Motor Requirements.

F. Control: Multiple speed switch, factory wired, located in cabinet, and disconnect.

G. Filter: Easily removed, located to filter air before the coil. Permanent washable type or one inch thick glass fiber throwaway type.

H. Capacity: As scheduled.

I. Electrical Characteristics:

1. Horsepower, voltage, and phase as scheduled on the Drawings, 60 Hz.

2. Refer to Divisions 26, 27 and 28.

J. Manufacturers: Modine, Sterling, Rittling, Trane, Vulcan.

2.4 HYDRONIC RADIANT CEILING PANELS

A. Panel shall consist of extruded aluminum with copper tubing of 0.50 inch ID mechanically attached to the aluminum faceplate. Hold copper tubing in place with an integral aluminum saddle or similar metal fastener which positively secures the tube to the panel. Use of adhesives or clips is not acceptable.

B. Not all panel hardware, mounting and attachment components and features are detailed on the Mechanical and Architectural Drawings. Provide backing, supports, moldings, hangers, cross tees, seismic restraints, hardware, and other appurtenances required for a complete and properly operating finished system. Mechanical fasteners shall not be exposed in the finish work.

C. In addition to the Mechanical Drawings, refer to Architectural Reflected Ceiling Plans and Room Finish Schedule to determine other panel requirements.

D. Provide finish and color selected by the Contracting Agency.

E. Cross brace entire assembly with structural members and insulate with one inch thick fiberglass insulation. Configure panels within T-bar ceiling module and run wall to wall.

F. Heating Capacity: Panel total output rating shall be as scheduled when tested against an average unheated surface temperature (AUST) of 70 degrees F. Data shall be certified by qualified independent test lab.

G. Manufacturers: Sterling, Airtex, or Aero Tech AX.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection: Cover equipment and plug piping connections to protect components from construction dirt and debris.

B. Preparation: Prior to installation of terminal units, make sure wall construction is complete enough to correctly locate and mount units.

3.2 INSTALLATION

A. Install terminal equipment in accordance with manufacturer’s instructions.

B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.

C. Provide finished cabinet units with protective covers during balance of construction.

D. Finned Tube Radiation: Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Install end caps where units butt against walls.

E. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

F. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.

G. Hydronic Units:

1. Provide accessible ball type isolation valves on supply and return lines to each terminal unit to allow for unit drain down and repair.

2. Provide low-point drain valve that allows for complete gravity drawing of terminal unit.

3. Provide high-point automatic air vent as specified elsewhere.

H. Radiant Panels:

1. Provide each panel circuit with shutoff valve on supply and return piping.

2. Install in accordance with the manufacturer's shop drawings.

3. Coordinate with ceiling system and other related work.

4. Mechanical fastenings shall not be exposed in the finished work.

5. Install suspension system in accordance with ASTM C636.

6. Completely cover panel with minimum of 1 inch of fibrous glass, unfaced blanket insulation.

7. Do not connect to supply and return system until system has been flushed and cleaned.

I. Access Doors: Install such that a drain hose may be easily connected to each drain line hose bibb, allowing the applicable portion of the system to be completely drained.

J. Install balancing valves and serviceable products for heating terminal units to be operable and adjustable without removal of the finish cover.

K. Provide pressure and temperature test plugs on both sides of heat transfer elements to measure the drop across runs of heat transfer elements.

L. In systems containing glycol, provide only products specifically designed and approved for continuous operation with the glycol solution specified.

3.3 CONSTRUCTION

A. Interface with Other Work:

1. Coordinate and sequence installation of terminal heating and cooling units with trades responsible for portions of this and other related sections of the Project Manual.

2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Verify units are installed and operational in accordance with the manufacturer's written installation instructions.

2. Both the Contractor and Manufacturer's Representatives shall sign start-up and operational checklist to confirm proper unit installation and operation.

3.6 ADJUSTING

A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.

B. Coordinate and work directly with the Testing, Adjusting and Balancing Agency to provide systems in proper operating order. Make corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

3.7 CLEANING

A. After construction is completed (including painting), and prior to initial start-up, clean and wipe down exposed surfaces of units. Vacuum clean coils and inside of cabinets and enclosures.

B. Touch up marred or scratched surfaces of factory finished cabinets and enclosures, using finish materials furnished by manufacturer.

C. Clean permanent filters or install new disposable filters.

3.8 DEMONSTRATION AND START-UP

A. Start-up and operate terminal heating and cooling units in accordance with the manufacturer's written installation and operation manual check list.

B. Demonstrate proper system operation using the building automation system.

C. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

END OF SECTION 238200

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 238316 - RADIANT FLOOR HEATING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Radiant floor heating systems.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200529 - Mechanical Hangers and Supports
4. 200548 - Mechanical Vibration and Seismic Control
5. 200553 - Mechanical Identification
6. 200556 - Interior Trench Excavation and Backfill
7. 200700 - Mechanical Insulation
8. 230593 - Testing, Adjusting and Balancing
9. 232113 - Hydronic Piping and Specialties
10. 232123 - Hydronic Pumps
11. 253000 - Building Automation System Field Devices
12. 255000 - Building Automation System
13. 259000 - Sequence of Operations

1.2 REFERENCES

A. International Mechanical Code (IMC).

B. NFPA 70 - National Electrical Code.

C. REHAU Radiant Floor Heating Systems - Technical Manual (Latest edition).

D. WIRSBO Complete Design Assistance Manual (Latest Edition).

E. DIN 4726 - Standard for Plastic Piping used in Warm Water Floor Heating Systems.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. This section describes specific requirements, products and methods of execution for radiant floor hydronic heating systems.

2. Provide a complete, pre-engineered radiant slab heating system which automatically maintains a constant interior temperature setpoint for each radiant floor heating zone as shown.

3. Not all hardware, components, and features are detailed on the drawings. Provide tubing, manifolds, fittings and hardware, isolation valves, strainers, drain valves, gauges, supports, and other appurtenances required for a complete and properly operating system.

B. Performance Requirements: Provide performance and output as shown or scheduled on drawings.

1.4 SUBMITTALS

A. Product Data:

1. Provide manufacturers' product literature and technical instructions, clearly annotated to indicate specified salient features and performance criteria.

2. Include the following:

a. Performance characteristics as scheduled.
b. Catalog data sheets for radiant floor tubing material, supports, tubing guides, spacers and associated items necessary for installation of tubing.
c. Catalog data sheets for each pump scheduled.
d. Dimensional data.
e. Features and appurtenances being provided.
f. Electrical characteristics and connection requirements.

B. Shop Drawings:

1. Refer to Section 200000 - Mechanical General Requirements for general shop drawing requirements.

2. Provide engineering design calculations that confirm heat output performance, pumping flow (GPM) requirements, pumping head requirements and supply water temperature requirements. Include circuit balancing data necessary for system start up.

3. Provide radiant floor heating system shop drawings which indicate:

a. Each radiant zone location and BTUH/SF heating performance.
b. Zone tubing patterns, tube spacing, tubing diameters, number of circuits and circuit lengths.
c. Location of in-floor electrical raceways and ductwork, slab control joints and construction joints, and typical tube routing detail where piping must cross raceways

or joints. Indicate these items in sufficient detail, including dimensioned locations of system components, to demonstrate complete coordination between trades.
d. Location of floor drains and other floor penetrations.
e. Manifold, circulator pump and hydronic supply and return piping locations.
f. System piping diagram showing piping arrangement, circulation and injection pumps, control valves, isolation valves, balance and drain valves, test fittings and vents, temperature sensors and other appurtenances.

4. Indicate mechanical and electrical service locations and requirements.

C. Quality Assurance/Control Submittals:

1. Design Data and Test Reports:

a. Provide design data for system components.
b. Provide test report for system operation.

2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:

a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
b. Include with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
1). Printed names and signatures of the installers.
2). Documentation from Manufacturer's representative and Contracting Agency that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.

D. Closeout Submittal:

1. Project Record Documents:

a. Record actual locations of under floor system components, including tubing layout, temperature sensors, and other items as applicable.
b. Indicate locations of floor drains and other floor penetrations.
c. Indicate locations of under floor electrical raceways, ductwork, control joints and construction joints.

2. Operation and Maintenance (IO&M) Manuals:

a. Refer to Section 200000 - Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
b. Provide copies of approved submittal information for inclusion within the project IO&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list.

3. Warranty:

a. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.
b. Provide to the Contracting Agency one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

2. Acceptable Installers: Minimum three years experience in the installation and start-up of radiant floor heating systems.

B. Pre-Installation Meeting: Coordinate installation of radiant floor heating system components with trades responsible for portions of this and any other related sections of the Project Manual prior to installation.

C. Regulatory Requirements: Products Requiring Electrical Connection - Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site:

1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

B. Storage and Protection:

1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.

2. Store PEX tubing in original factory packaging, out of direct sunlight, until ready for installation.

3. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

4. Replace damaged items with same item in new condition.

1.7 WARRANTY

A. See Section 200000 - Mechanical General Requirements, for general mechanical warranty requirements.

B. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty, including the following:

1. Manufacturer's Project Start-up and Site Inspection Report.

2. Documentation demonstrating compliance with the Technical Information Manual.

3. Other documentation as required to validate the warranty.

C. Provide to the Contracting Agency one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Unless specified otherwise, provide products from the same manufacturer as part of a proven pre-engineered and cataloged system:

1. Uponor (Basis of Design).

2. Rehau.

3. Mr. Pex (manufactured by LK Pex AB).

4. Approved equal.

2.2 TUBING, FITTINGS AND FASTENERS

A. Tubing:

1. High density cross-linked polyethylene (PEX) tubing with co-extruded oxygen diffusion barrier, manufactured in accordance with ASTM F877 and DIN 4726. Tubing material shall be fully cross-linked to the specified standard prior to shipment from the manufacturer.

2. Tubing diameter as scheduled or as shown on the drawings. Minimum nominal inside diameter: 1/2 inch.

3. Maximum operating temperature: 180 degrees F.

4. Maximum operating pressure: 100 PSIG.

B. Tube Fittings:

1. Brass compression sleeve and coupling, for locations which are inaccessible after installation.

2. Brass compression union nut fittings, for locations which are accessible after installation.

C. Tubing Anchors:

1. For tubing secured to wire mesh.

a. Molded plastic Star clips.
b. Nylon cable ties.

2. For tubing secured to rigid insulation or wood sub-floor.

a. Molded plastic Screw clips.
b. Molded plastic C-channels with integral tubing clips to allow accurate tube spacing.

2.3 MANIFOLD SUPPLY AND RETURN HEADERS

A. Brass construction.

B. Quarter turn ball isolation valves.

C. Individual circuit shutoff valves and balancing valves where shown on the drawings.

D. Air vents with isolation valves.

E. Low point drain valves with 3/4-inch threaded hose connections and end caps.

F. Maximum number of circuits on a single manifold: 12.

2.4 MANIFOLD ENCLOSURES

A. Provide a factory-built manifold enclosure (distribution cabinet) of a size appropriate for the manifold, as shown on the drawings:

1. Fully recessed enclosure:

a. Adjustable floor-mounted base.
b. Header mounting rails.
c. Wall Frame.
d. Cover trim with access door.

B. Field fabricated enclosure assemblies are not acceptable.

2.5 SENSORS

A. Temperature sensors:

1. Provide air temperature sensors, slab temperature sensors, supply / return water temperature sensors and other sensors as indicated on the drawings for a complete and operational system.

2. See Section 255000 - Building Automation System for additional sensors.

2.6 SYSTEM CONTROLS

A. radiant floor systems controlled by the Building Automation System; no separate control system is required. Refer to Section 259000 - Sequence of Operations.

2.7 VALVES

A. For radiant floor systems controlled by the Building Automation System, motorized valves are provided under Section 255000 - Building Automation System.

B. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Balancing valves:

1. Manufacturers: Bell & Gossett, Taco.

2. Calibrated plug or ball valve type balancing valves with self-sealing quick connect pressure taps, scale and locking device.

D. Isolation valves: Ball valve, unitized type, bronze body and ball, TFE seats.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection: Cover equipment and plug piping connections to protect components from construction dirt and debris.

B. Preparation:

1. Verify that slab insulation, vapor barrier, reinforcing steel and other structural items are complete and ready for tubing installation.

2. Verify locations of slab control, construction and expansion joints.

3. Verify locations of floor penetrations, ventilation floor outlets, underground electrical trenches, structural elements and other items that may affect tubing installation.

4. Verify that appropriate electrical connections are available, with the proper voltage and phase characteristics.

5. Coordinate timing of work so that radiant floor tubing installation does not interfere with the work of other trades. Minimize construction activity in the area to prevent damage to tubing and other system components.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions. Where possible, use manufacturer's specialty tools.

B. Refer to structural drawings for slab construction details. Tubing attachment method and frequency in accordance with manufacturer's recommendations.

C. Where tubing crosses slab expansion, control or construction joints, route piping under joints or provide a sleeve over tubing extending 10 inches minimum beyond the joint. Sleeve material as specified in the manufacturer's installation guide.

D. Where tubing exits the slab, provide a sleeve over tubing extending 10 inches minimum into the floor and above the floor. Sleeve material as specified in the manufacturer's installation guide.

E. Lay out supply piping, pumps, manifolds and other components in a neat and logical fashion. Verify that components are accessible for servicing, adjustment and removal.

F. Install drain valves such that a drain hose may be easily connected, allowing that portion of the system to be completely drained.

3.3 CONSTRUCTION

A. Interface with Other Work:

1. Coordinate and sequence installation of radiant floor heating system components with trades responsible for portions of this and other related sections of the project.

2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Owner.

3.4 REPAIR/RESTORATION

A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

B. Substitute replacement parts from other manufacturers are not acceptable.

3.5 FIELD QUALITY CONTROL

A. Flush and purge piping and manifold in accordance with manufacturer's installation guide. Verify that debris and air has been removed from floor circuits, manifold headers and supply piping.

B. Pressure Testing:

1. Prior to pouring the slab, perform a water pressure test as recommended by the manufacturer. Air testing is not acceptable. Pressurize with water for the length of time specified. If the maximum pressure drop is exceeded, repair leaks and re-test.

2. Pressure gauges used for testing must show pressure increments of 1 PSIG and be located at or near the lowest point in the system.

3. Comply with local codes during pressure testing. Where required, pressure tests should be witnessed by the Authority Having Jurisdiction.

4. Maintain operating system pressure during slab installation.

5. Complete the manufacturer's inspection and test reports showing acceptable performance and submit with warranty and IO&M documentation. Include the following:

   a. Manufacturer's Project Start-up and Site Inspection Report.
   b. Documentation demonstrating compliance with the Technical Information Manual.
   c. Other documentation as required.

C. Manufacturer's Field Services:

1. Verify system is installed and operational in accordance with the manufacturer's written installation instructions.

2. Both the Contractor and Manufacturer's Representative(s) shall sign start-up and operational checklist to confirm proper system installation and operation.

3.6 CLEANING

A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down external system components and inside manifold cabinet.

3.7 DEMONSTRATION & START-UP

A. Start-up and operate radiant floor heating systems in accordance with the manufacturer's written installation and operation manual checklist. Allow sufficient slab curing time before startup.

B. During initial start up, bring slab up to temperature slowly in order to minimize the possibility of thermal shock.

C. Demonstrate proper system operation using the building automation system.

D. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

3.8 BALANCING

A. Coordinate and work directly with the Balancing and Testing Agency to provide systems in proper operating order. Make corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

END OF SECTION 238316

SECTION 253000 - BUILDING AUTOMATION SYSTEM FIELD DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements, products, procedures, performance requirements, and methods of execution relating to the Building Automation System (BAS) terminal devices and field hardware.

2. Refer to related sections for other technical requirements, products, and methods of execution relating to the controls system for monitoring and control of mechanical systems.

B. Related Sections: Refer to Section 255000 - Building Automation System.

1.2 REFERENCES

A. Refer to Section 255000 - Building Automation System.

1.3 SYSTEM DESCRIPTION

A. Refer to Section 255000 - Building Automation System.

1.4 PREINSTALLATION MEETINGS

A. Refer to Section 255000 - Building Automation System.

1.5 SUBMITTALS

A. Submit in accordance with Section 255000 - Building Automation System and in accordance with Division 1.

1.6 CLOSEOUT SUBMITTALS

A. Submit in accordance with Section 255000 - Building Automation System and in accordance with Division 1.

1.7 QUALITY ASSURANCE

A. Refer to Section 255000 - Building Automation System.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 255000 - Building Automation System.

1.9 SITE CONDITIONS

A. Refer to Section 255000 - Building Automation System.

1.10 WARRANTY

A. Refer to Section 255000 - Building Automation System.

PART 2 - PRODUCTS

2.1 TEMPERATURE SENSOR

A. Digital room sensors:

1. Temperature monitoring range: 55/95 degrees F.

2. Network jack.

3. Output signal: Changing resistance.

4. Accuracy at Calibration point: Plus or minus 0.5 degrees F.

5. Wall Mounted unit with finished cover:

a. Private offices and rooms:
1). LCD display, day/night override button, and setpoint slide adjustment override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment.
2). Set Point and Display Range: 55 degrees to 95 degrees F.

b. Public Spaces: Blank Cover.

B. Liquid immersion temperature:

1. Temperature monitoring range: Minus 40/240 degrees F.

2. Output signal: Changing resistance.

3. Accuracy at Calibration point: Plus or minus 0.5 degree F.

4. Provide immersion sensor assembly as specified. Immersion sensors shall include a separate thermowell for sensor installation. Annular space between well and sensor shall be filled with heat conductive compound.

C. Duct (single point) temperature:

1. Temperature monitoring range: 20/120 degrees F.

2. Output signal: Changing resistance.

3. Accuracy at Calibration point: Plus or minus 0.5 degrees F.

4. Sensing element shall be located a minimum of 25 percent across duct width.

D. Duct Average temperature:

1. Temperature monitoring range: 20/120 degrees F.

2. Output signal: 4-20 mA DC.

3. Accuracy at Calibration point: Plus or minus 0.5 degrees F.

4. Sensor Probe Length: 25 feet.

E. Outside air temperature:

1. Temperature monitoring range: Minus 58/122 degrees F.

2. Output signal: 4-20 mA DC.

3. Accuracy at Calibration point: Plus or minus 0.5 degrees F.

4. Provide NEMA3R rated mounting assembly (rain tight).

2.2 WALL MOUNTED SENSOR GUARD

A. Clear or opaque butyrate plastic guard, key lock, mounting plate.

2.3 ELECTRIC THERMOSTAT

A. Electric Room Thermostats: Low voltage, two position devices as indicated on the plans. Furnish standard manufacturing configurations of single or multi-stage as well as heating/cooling arrangements as required to provide an operable system. Thermostats shall be dual setpoint with deadband for heating and cooling.

B. Unit Heater Thermostat: Amperage capacity sufficient to cycle fan without need for contactor.

C. Remote Bulb Electric Thermostats: Precision snap acting, dust tight contacts; external adjustment by screwdriver slot or range adjusting knobs; operating temperature point in mid range of the instrument.

2.4 LOW TEMPERATURE DETECTION THERMOSTAT

A. Provide low temperature control thermostat, electric type manual reset, non-averaging 20 feet long sensing elements that switch whenever any 12-inch section or more of any portion senses a temperature as low as the thermostat setpoint as specified in sequences.

B. Provide with automatic reset with control system reset.

C. Provide with two sets of contacts, one for hardwired fan shutdown and one for remote monitoring.

2.5 HIGH AND LOW LIMIT THERMOSTATS

A. Provide electric, high or low limit thermostats as required by sequence of operation.

B. Freeze Protection Thermostats: Employ a 20 foot element. If any one foot section of the element is subjected to temperatures below 35 degrees F, the respective electric or pneumatic circuit opens, causing action to fans and dampers as required under the sequence of operations. Provide with automatic reset.

C. High Limit Thermostats (Fire Stats, etc.): Employ rod and tube type elements that extend approximately ten inches into the duct. If instrument is subjected to temperatures above 135 degrees F., action required by sequence of operation occurs.

2.6 DIGITAL STATUS POINTS

A. Digital status shall be monitored by sensing normally closed contacts (contact closed in alarm conditions). The addition of the monitoring relay shall not affect the operation of the systems involved.

2.7 DIGITAL COMMAND POINTS

A. Command relays shall be momentary, automatic, maintained, or magnetic latch fail/safe as required. Maintained contacts located in occupied spaces or plenum spaces shall be mechanically latched. Relays shall be plug in and field replaceable. Contact ratings shall be in accordance with service.

2.8 DIFFERENTIAL AIR STATIC PRESSURE SENSOR

A. Provide integral pressure transducer and transmitter in enclosure suitable for wall or panel mounting. 4-20ma output signal proportional to the input pressure span.

B. Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Transmitter range shall be bi-directional.

C. The following sensor locations with static pressure ranges are:

1. Supply duct static pressure: Plus or minus 2.0 inch W.C.

2. Filter bank static pressure drop: Plus or minus 1.5 inches W.C.

3. Air flow station: Varies based on manufacturer recommendations.

D. Temperature operating range: 32 to 122 degrees F.

E. Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy plus or minus 0.5 percent of full scale. Linearity plus or minus 0.1 percent.

2.9 EXTERIOR AIR STATIC PRESSURE REFERENCE HEAD

A. Provide parallel plate reference heads with mounting pipe, brackets, supports, and guys for complete installation.

B. Accuracy: Capable of sensing outside air pressure within 2 percent of actual value when subjected to radial wind velocities up to 40 mph with approach angles up to 30 degrees to the horizontal.

C. Provide a one-liter capacity volume chamber with restrictor between the exterior air static reference head and the pressure sensor.

2.10 ROOM PRESSURE MONITORS

A. Room Pressure Monitors shall be suitable for directly controlling supply and exhaust air to maintain a differential pressure setpoint relative to an adjacent room.

B. Provide a pressure sensor with the following features:

1. Through wall velocity sensor with integral algorithms to calculate temperature compensated differential pressure across wall with a range of minus 0.200 inch wg to plus 0.200, accurate to .0001 inch wg.

2. ANSI/UL 1479 listed for “Fire Tests of Through-Penetrations Firestops”.

C. Provide a monitor panel with following features:

1. Audible and visual alarm capability.

2. 24 VAC input power.

3. Keypad and display to program panel and display room pressure information.

4. The panel shall monitor room differential pressure to an adjacent room. The panel shall have the following points:

a. Zero to 10 V output suitable for controlling HVAC equipment.
b. Adjustable room pressure alarm contacts for high and low pressure.

D. Manufacturer: TSI Inc.

2.11 INTERIOR AIR STATIC PRESSURE PROBE

A. Provide shielded static air pressure probe with appurtenances for complete installation. Integral volume chamber, sensing ports engineered for quiet, steady operation.

B. Accuracy: Capable of sensing room air pressure within 1 percent of actual static pressure value.

2.12 DIFFERENTIAL FLUID PRESSURE SENSOR

A. Provide integral pressure transducer and transmitter with 4-20 mA output signal proportional to the input pressure span.

B. Provide NEMA 1 aluminum enclosure.

C. Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Transmitter range shall be unidirectional.

D. The range for the sensor serving the hydronic heating system is 0-10 psig.

E. Temperature operating range: Minus 40 to 175 degrees F.

F. Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy plus or minus 1.0 percent of full scale.

2.13 FLUID PRESSURE SENSOR

A. Provide integral pressure transducer and transmitter with 4-20 mA output signal proportional to the input pressure span.

B. Provide watertight enclosure.

C. Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Transmitter range shall be unidirectional.

D. The range for the sensor serving the hydronic heating system is 0-50 psig.

E. Temperature operating range: Minus 40 to 200 degrees F.

F. Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy plus or minus 1.0 percent of full scale.

2.14 AIRFLOW MEASURING STATION/DEVICE

A. One or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

B. Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors. The airflow rate of each sensor assembly shall be equally weighted and averaged

by the transmitter prior to output. Devices using less than two thermistors in each sensor assembly are not acceptable.

C. Devices using platinum wire RTDs are not acceptable.

D. Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.

E. Airflow accuracy shall be +/-2 percent of Reading over the entire operating airflow range.

F. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

G. Temperature accuracy shall be +/-0.15 degrees F over the entire operating temperature range of -20 degrees F to 160 degrees F.

H. The operating humidity range for each sensor probe shall be 0-99 percent RH (non-condensing).

I. Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter.

J. The number of sensor housings provided for each location shall be as follows:

Duct or Plenum Area (sq.ft.)	Total # Sensors / Location
<2	4
2 to < 4	6
4 to < 8	8
8 to <16	12
>=16	16

K. Fan inlet sensors may be proposed where appropriate.

L. The transmitter shall communicate directly with the building automation system utilizing a LonWorks protocol.

M. Manufacturer: Ebron Gold Series or equal.

2.15 GAS DETECTION AND VENTILATION CONTROLS SYSTEM

A. Provide gas detection and ventilation control systems as scheduled on the drawings and specified herein.

B. Basis of Design: Toxalert, Model GVU-3 or GVU-6 as scheduled.

C. Sensors:

1. Carbon Monoxide (Gasoline Exhaust Engine):

a. Provide remote Carbon Monoxide (CO) sensors as located on the drawings. The remote CO sensor shall utilize a solid state sensing element, be microprocessor based and be both temperature and humidity compensated for long life and stability. Pilot lights or LED'S (light emitting diodes) shall indicate:
1). Unit normal operation/NOT in alarm.
2). High CO/unit in alarm.
3). Unit malfunction.

b. In the unit malfunction condition, the CO sensors output shall be fail-safe and indicate steady high CO condition. The CO sensor range shall be 0 to 250 parts per million (ppm) and shall be powered by low voltage from GVU control unit.

2. Nitrogen Dioxide (Diesel Engine Exhaust):

a. Provide Nitrogen Dioxide (NO2) sensors as located on the drawings. The remote sensor shall utilize an electrochemical element and have a range of 0-10 ppm. The sensor shall be housed in an impact-resistant, non-flammable, IP66 rated housing. The sensor response time shall reach 90% of level being sensed within 30 seconds. The sensor shall be powered by low voltage from the GVU control unit and have an LED to indicate sensor "OK".

D. System Controller:

1. The system controller shall continuously monitor its remote sensors. When an alarm condition is detected, the controller shall delay fan/damper contact closure for 30 seconds. If the high gas condition persists for more than 30 seconds, the fan/damper contacts shall close. The minimum contact closure time shall be field settable from one to eight minutes, in one minute increments. Should the alarm condition remain after the minimum run time has timed out, the contacts shall remain closed and a second "alarm" set of contacts shall close.

a. System controller shall interface with facility's BAS to implement ventilation equipment as specified elsewhere. See 25 9000 - Sequence of Operations.

2. The controller shall include separate internal LED's for each remote sensor to indicate which sensor is indicating a high gas condition. The controller shall be powered by 120VAC, 60Hz, 1Amp (fused) and provide all low voltage power to remote sensors. 24VAC, 2A resistive, 1.5 inductive auxiliary relay contacts shall be provided for remote control.

3. Provide the following control panel options:

a. Power "ON" indicator on face of controller to indicate power to system.
b. LED on face of panel to indicate high gas alarm condition. One for each sensor.
c. Fan/Damper "ON" indicator on face of controller to indicate fan/damper stage.

d. Audible and visual alarm with horn silence switch.
   1). Audible alarm with a minimum sound intensity of 68dB on the face of the control panel. Provide an "Audible Reset" push button switch to silence the audible alarm. Audible silence circuit shall be self resetting so that after alarm is cleared, the audible alarm with automatically resound on the next alarm activation.

e. Keyed panel lock.

2.16 CURRENT SENSOR

A. Provide current sensors that convert AC current to a proportional (4-20 mA) DC current.

B. Provide reverse voltage and high over current capacity.

C. Provide red LED light to indicated relay status and power.

D. Temperature operating range: 5 to 140 degrees F.

E. Provide UL Listed device.

2.17 CURRENT SENSING RELAY

A. Provide solid-state, self-calibrating, current operated relay suitable for equipment status monitoring. Provide a relay that changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.

B. Provide red LED light to indicated relay activation.

C. Temperature operating range: minus 30 to 140 degrees F.

D. Provide UL Listed device that is rated for plenum installation.

2.18 RELAYS

A. Applications: Relays external to the controls shall include (but not be limited to) the following:

1. Control relays for start/stop or open/close control of equipment.

2. Monitoring relays for electrical circuit on/off or open/closed status detection.

3. Interposing relays to provide interface between solid state circuitry and ac-driven control relays.

B. Requirements: Relays shall be housed in dust-tight cases conveniently located for wiring and inspection:

1. Control Relay: Control relays shall be suitable for continuous operation of 120 VAC and be able to interrupt the control circuits of various HVAC equipment. The number of

contacts required for the relay shall be determined from the number of independent equipment to be controlled. The number of control relays required for the motor start/stop circuit shall be determined from examination of the equipment to be controlled.

2. Monitoring Relay: Monitoring relays shall be suitable for continuous operation at the voltages of the circuits to be monitored. The monitoring relays shall be connected in such a way that the operation of the relay contact shall represent the change of status of the monitored circuit (i.e. ON/OFF, etc.) or duplicate the operation of the existing alarm circuit (i.e. high/low, etc.). The addition of the monitoring relay shall not affect the operation of the systems involved.

3. Interposing Relay: Interposing relays shall be DC driven and be utilized to provide interface between solid state circuitry and ac-driven control relays as required.

2.19 CONTROL VALVE

A. Control Valve: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Globe Valve 2 inch and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and sweat ends.

C. Globe Valve 2-1/2 inch and Larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

D. Hydronic system globe valve shall have the following characteristics:

1. Rating: ANSI Class 125 for service at 125 psig and 32/250 degrees F. operating conditions.

2. Internal Construction:

a. Replaceable plugs and seats of stainless steel or brass.
b. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
c. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

3. Sizing: 3 psig maximum pressure drop at design flow rate.

4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.

5. Select heating valves shall fail to a Normally Open to heat position, unless otherwise indicated. Select cooling valves to normally closed to cooling position.

6. Three-way valves: Mixing type, unless otherwise indicated.

2.20 CONTROL DAMPER

A. Rectangular:

1. Frame: Five inches by one inch by minimum 0.125 inch 6063-T5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.

2. Blades: Provide airfoil-shaped, single-piece blades made of heavy-duty 6063-T5 extruded aluminum. Maximum six inch blade width.

3. Bearings: Molded synthetic sleeve, turning in hole in frame.

4. Seals:

a. Blade: Extruded vinyl type for ultra-low leakage from minus 50 degrees F. to 350 degrees F. Mechanically attached to blade edge.
b. Jamb: Flexible metal compression type.

5. Linkage: Concealed in frame.

6. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade.

7. Finish: Mill aluminum.

8. Performance Data:

a. Temperature Rating: Withstand minus 50 degrees F. to 350 degrees F.
b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions:
1). Closed Position: Maximum pressure of 13 inches W.C. at a 12-inch blade length.
2). Open Position: Maximum air velocity of 6,000 feet per minute.

c. Leakage: Maximum 2.0 cubic feet per minute per square foot at 1.0 W.C. for sizes 24 inches wide and above.
d. Pressure Drop: Maximum 0.03 inch W.C. at 1,500 feet per minute across 24 inch by 24 inch damper.

9. Manufacturer: Ruskin CD50, Louvers and Dampers, Air Balance, Pottorff, or equal.

B. Round:

1. Frame:

a. Under 6 inches Diameter: 2 inches by 1/2 inch minimum 12 gage galvanized steel tube.
b. 6 thru 12 inches Diameter: 2 inches by 1/2 inch by minimum 14 gage galvanized steel channel.
c. Above 12 thru 24 inches Diameter: 2 inches by 1/2 inch by minimum 1/8 inch galvanized steel channel.

d. Above 24 inches Diameter: 2 inches by 1 inch by minimum 3/16 inch galvanized steel channel.

2. Blade: Provide single-piece construction made of the following material:

a. 18 inches diameter and smaller: Minimum 12 gage galvanized steel.
b. Over 18 inches diameter: Minimum 10 gage galvanized steel, stiffeners as required.

3. Blade Seals: Closed cell polyethylene foam rubber fully encompassing and mechanically attached to blade edge.

4. Bearings: Self-lubricating stainless steel sleeve.

5. Axles:

a. 22 inches Diameter and smaller: Minimum 1/2 inch diameter, full length, plated steel, mechanically attached to blade.
b. Over 22 inches Diameter: Minimum 3/4 inch diameter, full length, plated steel, mechanically attached to blade.

6. Finish: Mill.

7. Performance Data.

a. Temperature Rating: Withstand maximum 250 degrees F.
b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
   1). Closed Position: Maximum pressure of 10 inches W.C.
   2). Open Position: Maximum air velocity of 4,000 feet per minute /min.

c. Leakage: Maximum 10 cubic feet per minute total at 1 inch W.C.
d. Pressure Drop: Maximum 0.05 inch W.C. at air volume of 7,000 cubic feet per minute through 24 inch diameter damper.

8. Manufacturer: Ruskin CDR25, Louvers and Dampers, Air Balance, Pottorff, or equal.

2.21 VALVE AND DAMPER ACTUATORS

A. General:

1. Provide electronic direct-coupled actuation for control valves and dampers.

2. Proportional actuators shall accept a 0-10 VDC or 0-20 mA control input and provide a 2-10 VDC or 4-20 mA operating range. Damper actuators and control valve actuators serving valves larger than 3/4” shall provide a 2-10 VDC position feedback signal. The feedback signal shall be independent of the input signal.

3. Actuators indicated by Normally Closed or Normally Open designation on drawings or in sequence of operation shall be spring return type.

4. The actuator shall have electronic overload circuitry to prevent damage to the actuator.

5. Provide actuators listed by Underwriters Laboratories Standard 873 Standard for Safety Temperature-Indicating and -Regulating Equipment.

B. Damper Actuator:

1. Provide damper actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage.

2. Spring return actuators shall be capable of both clockwise and counterclockwise spring return operation by simply changing the mounting orientation.

3. Non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 inch-pounds torque capacity shall have a manual crank for this purpose.

4. Provide actuators in sufficient size, quantity and type to match application. Provide a minimum of one damper actuator for each 24 square feet of damper area. Damper areas shall not exceed manufacturer's ratings.

5. Outside air and return air dampers on mixing boxes shall be linked such that one opens while the other closes. It shall not be possible to close both dampers simultaneously.

6. Dampers: Size for minimum running torque calculated as follows:

a. Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
b. Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
c. Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. of damper.
d. Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
e. Dampers with 2 to 3 Inches W.C. of Pressure Drop or Face Velocities of 1000 to 2500 FPM: Multiply the minimum full-stroke cycles above by 1.5.
f. Dampers with 3 to 4 Inches W.C. of Pressure Drop or Face Velocities of 2500 to 3000 FPM: Multiply the minimum full-stroke cycles above by 2.0.
g. Values noted above do not include normally open or normally closed open spring return dampers. Provide additional torque as required.

7. Size operators with ample power to overcome friction of damper linkage and air pressure acting on the damper blades.

C. Valve Actuator:

1. Provide actuators with enough torque and force required for proper valve close-off against the system pressure.

2. The valve actuator shall be sized based on valve manufacturer's recommendations for flow and pressure differential.

2.22 INSTRUMENT ENCLOSURE

A. Steel construction with hinged and lockable doors.

B. NEMA 12 construction only in areas where panels are subject to moisture damage.

C. Wiring connections including I/O and power shall be extended to a numbered, color-coded, and labeled terminal strip for ease of maintenance and expansion.

D. Provide labeling and color coding for wiring. Wiring shall follow a common format typical for the entire facility. Terminal strip color coding and numbering shall follow a common format. Wiring shall be neatly installed in plastic trays or tie-wrapped.

E. Line voltage wiring shall be segregated from I/O wiring and shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

F. Provide a convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers. Provide convenience receptacle for enclosures containing equipment that can be configured or adjusted with a portable computer.

2.23 POWER SUPPLY

A. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75 percent of the rated capacity of the power supply.

B. Input: 120 VAC plus 10 percent, 60Hz.

C. Output: 24 VDC.

D. Line Regulation: Plus 0.05 percent for 10 percent line change.

E. Load Regulation: Plus 0.05 percent for 50 percent load change.

F. Provide an appropriately sized fuse and fuse block shall be provided and located next to the power supply.

G. Provide a power disconnect switch shall be provided next to the power supply.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Special Techniques:

1. Wiring:

a. The HVAC Control Contractor shall provide conduit, wiring, accessories, and wiring connections required for the installation of the control system, as herein specified, unless specifically shown in Divisions 26, 27 and 28.

b. Conduit and wiring shall comply with the requirements of applicable portions of Divisions 26, 27 and 28 and local and national electric codes, unless specified otherwise in this section.
c. System input wiring shall be twisted shielded pair, minimum 20 gauge wire. System analog output wiring shall be twisted shielded pair/3-wire as required, minimum 20 gauge wire. Preconfigured cables between Terminal Unit Controllers and Thermostats are acceptable, minimum 24 gauge.
d. Internal panel device wiring for binary outputs and pilot relay shall be minimum 16 gauge wire.
e. Provide separate conduit for control system power wiring including but not limited to 120 VAC and greater. I/O sensor wiring and data communication cabling shall be segregated from 120 VAC control system power wiring.
f. Wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size 3/4 inch. One half inch conduit may be used for thermostats and valve stub-ups where conduit contains only a single pair.

2. Temperature Sensors:

a. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.
b. Outdoor installations shall be of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel.
c. Wall Mounted Sensor and Thermostats:
   1). Install adjustable wall mounted room sensors at a height of 48 inches above finish floor level.
   2). Locate sensors as shown on the Drawings.
   3). Provide insulated base for sensors mounted on sheet metal, steel columns or exterior walls. Wire penetrations shall be caulked airtight to prevent thermal convection.
   4). Provide heavy-duty guards for sensors and thermostats in public areas and as shown on the Drawings.

d. Fluid Temperature Sensor: The sensor shall have a separable well suitable for insertion in a pipeline or vessel. Cable connections shall be suitable for the highest temperature expected and low temperature sensors shall be sealed to exclude condensation of atmospheric moisture.
e. Duct Temperature Sensor: The sensor shall measure the representative temperature of the entire cross-section of the duct or plenum. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces. Ductwork shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.
f. Mixed Air Temperature Sensors: The sensor shall be of the averaging type. Mount sensors with consideration for stratification of warm and cold air streams. Minimum binding radius for averaging sensors is four inches. Provide a minimum of one foot of averaging sensor element for each square foot of ductwork. Sensing element shall be installed such that it crosses completely through stratified airflow with complete passes. Partial passes are not allowed. If averaging sensor is not available provide one sensor for every four square feet of duct cross section area.

g. Fluid Temperature Sensors: Provide sensors with thermal wells fabricated and installed for the intended service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand all pressures, (including test pressures) and velocities to which they are subjected. Well shall not restrict flow area to less than 70 percent of line-size-pipe normal flow area. Where piping is smaller than the length of the well or exceeds the area requirements, the well shall be installed at an elbow and installed to effect uniform flow across the well. Sensors installed in wells shall be installed in horizontal piping below the pipe centerline.
h. Low Temperature Detection Thermostats: Mount sensor element similar to Mixed Air Temperature Sensors.

3. Exterior Air Static Pressure Reference Head:

a. Provide outside static reference heads and locate as shown on the Drawings.
b. Mount reference heads above roof line and in accordance with manufacturer recommendations.

4. Interior Air Static Pressure Probe:

a. Provide interior static pressure probes.
b. Provide surface mount in mechanical spaces. Provide recessed mount in finished spaces.

5. Differential Fluid Pressure Sensor:

a. Locate sensors as shown on the Drawings. Mount in accessible location.
b. Controls subcontractor to furnish differential pressure sensor snubbers. Installation of snubbers by plumbing subcontractor.

6. Fluid Pressure Sensor:

a. Locate sensors as shown on the Drawings. Mount in accessible location.
b. Controls subcontractor to furnish fluid pressure sensor snubbers. Installation of snubbers by plumbing subcontractor.

7. Carbon Dioxide Sensors: Locate sensors as shown on the Drawings.

8. Current Sensors:

a. Provide flow proof for constant volume fans and pumps with a current sensor connected to the motor wiring at the starter. Set upper alarm limit to the maximum rated current of the motor, or as advised by the TAB Agency. Set lower alarm limit at 1/2 the motor running amps.
b. Provide flow proof for variable speed control system through utilization of the variable speed drive serial communication option. Drive will communicate directly with BAS system.

9. Digital Status, Digital Command Points, Lighting Controls:

a. Provide relays in a separate instrument enclosure or control panel adjacent to the monitored or controlled equipment. The relays shall mounted and connected in a manner that does not violate controlled equipment listing or code requirements.
b. Provide relays that operate in conjunction with the motor control system. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
c. Coordinate motor control requirements with Divisions 26, 27 and 28.
d. Coordinate lighting control requirements with Divisions 26, 27 and 28.

10. Identification:

a. Panel and Instrument Enclosure Identification: Panels and instrument enclosures shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
b. Field Devices: Field devices shall be identified by a typed (not handwritten) securely attached tag label.
c. Panel or Instrument Enclosure Devices: Devices shall be identified by a typed label securely fastened to the backplane of the local control panel or instrument enclosure.
d. Wall Mounted Temperature Sensors: Device covers shall be identified by a typed label securely fastened to the front cover. The label shall indicate the terminal unit zone identification tag.
e. Raceway Identification: The covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating “Control System” affixed to the covers. This requirement includes control system tubing. Labels shall be typed, not hand written.
f. Wire Identification: Low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed.

3.2 SYSTEM STARTUP

A. Commissioning: Perform tests and verification procedures required for the commissioning process as requested by the Owner and directed by the Owner's Commissioning Authority.

3.3 MAINTENANCE

A. Arrange work so that wherever possible serviceable or operable products are located within mechanical or electrical spaces and are accessible.

END OF SECTION 253000

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 254000 - VARIABLE SPEED DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides specification requirements for solid-state, pulse-width modulated (PWM) Adjustable Frequency Drives, herein referred to as AC Drives, for use with NEMA design AC motors. The term “VSD” (Variable Speed Drive) is also used in this specification.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200513 - Common Motor Requirements
4. 200553 - Mechanical Identification
5. 230593 - Testing, Adjusting and Balancing
6. 232123 - Hydronic Pumps
7. 233400 - HVAC Fans
8. 236400 - Packaged Water Chillers
9. 237323 - Central Air Handling Units
10. 253000 - Building Automation System Field Devices
11. 255000 - Building Automation System
12. 259000 - Sequence of Operations

1.2 REFERENCES

A. Codes and Standards:

1. ANSI/NFPA 70 - National Electrical Code (NEC).
2. Institute of Electrical and Electronic Engineers (IEEE): Standard 519, IEEE Guide for Harmonic Content and Control.
3. UL 508 - UL Standard for Safety Industrial Control Equipment.
4. UL 508C - UL Standard for Safety Power Conversion Equipment.

5. NEMA ICS 7.1 - AC Adjustable Speed Drive Systems.

B. Abbreviations, Acronyms and Definitions:

1. Refer to Division 01 for general abbreviations, acronyms, and definitions.

2. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.

3. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: This section describes specific requirements, products and methods of execution for variable speed drives.

B. Performance Requirements:

1. Provide product performance characteristics as specified or scheduled on drawings.

2. Operate variable speed drives in accordance with Section 259000 - Sequence of Operations.

1.4 PRE-INSTALLATION MEETINGS

A. Coordinate installation of variable speed drives with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

1.5 SUBMITTALS

A. Product Submittals: Submittals shall include the following information:

1. Outline dimensions, conduit entry locations and weight.

2. Customer connection and power wiring diagrams.

3. Complete technical product description including a complete list of options provided.

4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).

   a. The VSD manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5 percent.
   b. Input line filters shall be sized and provided as required by the VSD manufacturer to ensure compliance with IEEE standard 519. VSDs shall include a minimum of 3 percent impedance reactors, no exceptions.

B. Quality Assurance:

1. Submit startup reports.

2. Submit syllabus of training for review and approval.

C. O&M Manuals:

1. Submit Operation and Maintenance Manuals to include all information necessary for the operation and maintenance of the system.

2. Furnish a minimum two complete sets to owner, or more as otherwise noted in Division 1.

1.6 QUALITY ASSURANCE

A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.

B. The AC Drive and associated optional equipment shall be UL Listed according to UL 508 C - Power Conversion Equipment. As verification, a UL label shall be attached on the inside of the combination enclosure. A UL508A panel builders label does not meet specification.

C. The AC Drive shall be designed, constructed and tested in accordance with UL, CSA, NEMA, and NEC standards.

D. Every power converter shall be tested with an AC induction motor while loaded and temperature cycled within an environment chamber at 40 degrees C (104 degrees F).

E. VSDs and options shall be UL listed as a complete assembly. VSDs that require the customer to supply external fuses for the VSD to be UL listed are not acceptable. The base VSD shall be UL listed for 100 KAIC without the need for input fuses.

F. The AC Drive supplier shall furnish, field test, adjust and certify installed AC Drives for satisfactory operation.

G. Any exceptions/deviations to this specification shall be indicated in writing and included with the submittal.

H. Acceptable Manufacturers:

1. Approval of manufacturer does not relieve supplier of specification requirements.

2. VSDs that are manufactured by a third party and “brand labeled” shall not be acceptable.

3. The drive manufacturer shall have an existing:

a. Sales representative exclusively for HVAC/Pumping products, with expertise in HVAC/Pumping systems and controls.
b. An independent service organization.

4. Factory trained application engineering and service personnel that are thoroughly familiar with the VSD products offered shall be locally available at the specifying location.

5. Service availability: The supplier shall have a fully equipped service organization capable of guaranteeing response time within 48 hours of service calls to service VSD.

6. There shall be 24/365 support available via a toll free phone number.

1.7 TRAINING

A. Provide two hours of Owner operator training on operation and service diagnostics at the time of the equipment commissioning.

B. Training shall be conducted by the manufacturer's start-up and commissioning agents.

C. Training shall utilize Operation and Maintenance Manuals submitted and approved for this specific project.

D. Coordinate with the Contracting Agency to schedule training sessions with Owner's personnel.

E. Submit training syllabus that describes topics to be addressed.

1.8 WARRANTY

A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include parts, labor, travel time and expenses.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

A. The VSD Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from ABB or alternative systems will be considered providing that sufficient documentation is provided to satisfy the Contracting Agency that the equipment meets the requirements of the specification.

B. VSDs shall be Square D E-Flex enclosed drive controllers or approved equal.

2.2 GENERAL DESCRIPTION

A. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage.

B. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage.

C. The output power section shall change fixed DC voltage to adjustable frequency AC voltage.

D. The adjustable frequency drive package shall consist of a circuit breaker disconnect, line reactor, EMI/RFI filter, 120V control transformer, control circuit terminal board for digital and analog field wiring. The base VSD shall be UL listed for 100 KAIC without the need for input fuses.

E. The drive door shall have mounted and wired, Hand-Off-Auto switch, Manual Speed Potentiometer and AFC-Off switch.

F. The entire drive package shall be UL508C listed and coordinated with NEMA ICS 7.1. A UL508A panel builders label does not meet specification.

2.3 CONSTRUCTION

A. The AC Drive power converter shall be enclosed in a NEMA Type 12 enclosure with a circuit breaker disconnect, and user terminal strip connections. The enclosure shall provide dedicated user terminals for power and control device connection.

B. Include provisions to lock the disconnect in the OFF position with a padlock.

C. Enclosure and heat sink fans shall be accessible from the front and shall not require the removal of the AC drive power converter for fan replacement.

2.4 APPLICATION DATA

A. The AC Drive shall be sized to operate a variable torque load.

B. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 72 Hz.

2.5 ENVIRONMENTAL RATINGS

A. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and CSA standards.

B. The AC Drive shall be designed to operate in an ambient temperature from -10 to 40 degrees C (14 to 104 degrees F).

C. The storage temperature range shall be -25 to 65 degrees C (-13 to 149 degrees F).

D. The maximum relative humidity shall be 95 percent, non-condensing.

E. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 feet (1000 meters). For altitudes above 3300 feet (1000 meters), the AC Drive shall be de-rated per drive specifications.

F. The AC Drive shall meet the IEC 60721-3-3-3M3 operational vibration specification.

G. The AC Drive shall be Seismic Qualified to 2000 IBC Level 3 “Extreme” rating with an Importance Factor I_p=1.5.

2.6 RATINGS

A. The AC Drive shall be designed to operate at the input line voltage indicated on the equipment schedule.

B. The AC Drive shall operate from an input frequency range of 60 Hz (±) 5 percent.

C. The displacement power factor shall not be less than 0.98 lagging under any speed or load condition.

D. The efficiency of the AC Drive at 100 percent speed and load shall not be less than 97 percent.

E. The variable torque rated AC Drive over current capacity shall be not less than 110 percent for 1 minute.

F. The output carrier frequency of the AC Drive shall be programmable at 0.5, 1, 2, 4 or 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.

2.7 PROTECTION

A. Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.

B. The enclosure shall provide a fully coordinated 100,000 AIC current rating marked on the enclosure nameplate. Short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.

C. The AC Drive shall be protected against short circuits, between output phases and to ground.

D. The AC Drive shall have a minimum AC under-voltage power loss ride-through of 200 milliseconds (12 cycles).

E. The AC drive shall have a programmable ride-through function, which shall allow the logic to maintain control for a minimum of one-second (60 cycles) without faulting.

F. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 6 programmable restart attempts. The time delay before restart attempts will be 30 seconds.

G. Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a fault.

H. The AC Drive shall have a solid-state UL 508C listed overload protective device and meet IEC 60947.

I. The output frequency shall be software enabled to fold back when the motor is overloaded.

J. There shall be three skip frequency ranges that can be programmed to a bandwidth of ±2.5Hz.

2.8 ADJUSTMENTS & CONFIGURATIONS

A. The AC Drive will be factory programmed to operate specified optional devices.

B. The acceleration and deceleration ramp times shall be adjustable from 0.05 to 999.9 seconds.

C. The memory shall retain and record run status and fault type of the past eight faults.

D. The software shall have an energy economy function that, when selected, reduces the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio shall be maintained during acceleration. The output voltage shall then automatically adjust to meet the torque requirement of the load. Selectable volts/Hz ratio patterns do not meet specification; the function shall be automatically optimized.

2.9 KEYPAD DISPLAY INTERFACE

A. A keypad display interface shall offer the modification of AC Drive adjustments through a touch keypad. Electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be accessible.

B. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall be listed on the drive identification portion of the LCD display.

C. The keypad display shall have a hardware selector switch that allows the keypad to be locked out from unauthorized personnel.

2.10 OPERATOR CONTROLS

A. The control power for the digital inputs and outputs shall be 24VDC.

B. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs shall be current limited and shall not be damaged if shorted.

C. Pull-apart terminal strips shall be used on logic and analog signal connections in the power converter.

D. Two voltage-free relay output contacts shall be provided. One of the contacts shall indicate AC Drive fault status. The other contact shall indicate a drive run status.

E. The combination enclosure shall have the following dedicated operator controls:

1. Hand-Off-Auto switch.

2. Manual Speed Potentiometer.

3. AFC-Off switch.

F. The combination enclosure shall include terminal point connection for fire/freeze state interlock, to prevent drive operation. The interlock shall shut down the motor in the drive mode.

2.11 SERIAL COMMUNICATION

A. The AC Drive shall have BACnet communications capability. The BACnet communications card shall provide data communications with a host computer or other device via the existing BACnet network. Data exchanges shall give access to all drive functions:

1. Control: Start, stop, reset, and setpoint.

2. Monitoring: Status, current, voltage, thermal state, etc.

3. Diagnostics: Alarms.

B. The graphic display terminal or the integrated display terminal shall be used to access functions for communication configuration and diagnostics.

2.12 HARMONIC MITIGATION

A. Each drive shall include a minimum 3 percent line reactor mounted inside the drive enclosure to reduce power system harmonics and provide power quality protection for the drive. DC bus chokes do not meet specification and shall not be substituted.

B. EMI / RFI filters: VSDs shall include EMI/RFI filters. The onboard filters shall allow the VSD assemble to be CE Marked and the VSD shall meet product standard EN 61800-3 for the First Environment restricted level.

C. VSDs through 50HP shall be protected from input and output power mis-wiring. The VSD shall sense this condition and display an alarm on the keypad.

D. Additional Features: Furnished and mounted by the drive manufacturer. Additional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label:

1. A manual bypass system is not desired or required.

2. Provide a door interlocked, padlockable circuit breaker that will disconnect input power from the drive and internally mounted options.

3. Provide a fused disconnect (service switch).

4. The drive shall provide single-phase motor protection.

5. The following operators shall be provided:

a. Hand-Off-Auto.
b. Drive mode selector.

6. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided:

a. Power-on (Ready).
b. Run enable (safeties) open.
c. Drive mode select damper opening.
d. Drive running.
e. Drive fault.
f. Safety open.
g. Damper opening.
h. Damper end-switch made.

7. The digital inputs for the system shall accept 24V or 115VAC (selectable).

8. Customer Interlock Terminal Strip: provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. External safety interlocks shall remain fully functional whether the system is in Hand or Auto modes.

9. The VSD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VSD mode). The VSD system shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VSD system safety interlock (fire detector, freezestat, high static pressure switch, etc.) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

10. Class 20 or 30 (selectable) electronic motor overload protection shall be included.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection: Cover drives to protect components from construction dirt and debris.

3.2 INSTALLATION

A. Verify that the location is ready to receive work and the dimensions are as indicated.

B. Do not install VSD until the building environment can be maintained within the service conditions required by the manufacturer. Before and during the installation, the VSD equipment shall be protected from site contaminants.

C. Details of the installation shall comply with the manufacturer's applicable instructions.

D. Minimize the length of conductors between the drive and the motor to avoid motor damage from reflected wave phenomenon.

E. Where the field conditions dictate long lengths of conductors between the VSD and motor, provide necessary measures to protect motors from reflected wave phenomenon. Measures may include coordination with the motor manufacturers to provide higher insulation voltage ratings, protection devices such as output reactors or special terminators, or BJT inverter output.

F. Mounting of VSD shall be suitable for seismic anchorage and/or restraints as required by International Building Code.

G. VSDs shall be furnished under Divisions 20, 21, 22, 23, 25 and installed under Divisions 26, 27 and 28. The contractor shall install the drive in accordance with the recommendations of the VSD manufacturer as outlined in the installation manual.

H. Power wiring shall be provided under Divisions 26, 27 and 28. The contractor shall complete wiring in accordance with the recommendations of the VSD manufacturer, as outlined in the installation manual.

3.3 CONTROL WIRING

A. Control wiring and control devices shall be provided under the specification section in which the controlled equipment is specified. Coordinate related work.

B. Control wiring shall be routed completely separately from power wiring.

3.4 NAMEPLATES

A. Provide a nameplate for each VSD in accordance with Section 200553 Mechanical Identification. Coordinate names with mechanical equipment lists.

3.5 FIELD QUALITY CONTROL

A. Start up: Certified factory startup shall be provided for each drive by a factory authorized service center. A certified startup form shall be filled out for each drive with copies submitted and included in the O&M Manuals, and a copy kept on file by the manufacturer.

B. Training: Onsite training shall be provided as part of the startup service. The training shall include installation, programming, and operation of the VSD and serial communication.

END OF SECTION 254000

SECTION 255000 - BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: This section describes requirements, products, and methods of execution relating to the building automation controls system for the project.

B. Related Sections: Refer to related sections for other technical requirements, products, and methods of execution relating to the controls system for monitoring and control of mechanical systems.

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 230593 - Testing, Adjusting and Balancing
4. 232123 - HVAC Pumps
5. 233400 - HVAC Fans
6. 233600 - Air Terminal Units
7. 235223 - Cast Iron Boilers and Accessories
8. 236400 - Packaged Water Chillers
9. 237323 - Central Air Handling Units
10. 238123 - Dedicated Air-Conditioning Units
11. 238200 - Terminal Heating and Cooling Units
12. 238316 - Radiant Floor Heating Equipment
13. 253000 - Building Automation System Field Devices
14. 254000 - Variable Speed Drives
15. 259000 - Sequence of Operations
16. Divisions 26, 27 and 28 - Electrical

1.2 REFERENCES

A. Codes and Standards. Perform work in accordance with applicable national, state and local codes to include:

1. NFPA 70, National Electrical Code - NEC.

2. ANSI-C2, National Electrical Safety Code - NESC.

3. Underwriters Laboratory (UL) or approved equal.

4. Institute of Electrical and Electronics Engineers - IEEE.

5. National Electrical Manufacturers' Association - NEMA.

B. Abbreviations and Acronyms:

1. Building Automation System (BAS).

2. Direct Digital Control (DDC).

C. Definitions:

1. ASHRAE: The American Society of Heating, Refrigerating and Air-Conditioning Engineers.

2. BACnet: A Data Communication Protocol for Building Automation and Control Networks, ANSI/ASHRAE Standard 135-current edition, developed under the auspices of ASHRAE.

3. Bridge: A device that routes messages or isolates message traffic to a particular segment, sub-net or domain of the same physical communication media.

4. Building Automation System (BAS): Collection of sensors, operators, controllers, and interconnecting wiring that control the operation of the building mechanical and electrical systems as described in these specifications.

5. Field device or field control device: A physical component such as a temperature sensor, pressure sensor, contact, motor operated valve, and motor operated damper. Generally considered to bring only one point to a controller.

6. Gateway: A hardware/software package that allows communication between dissimilar (“foreign”) systems and different protocols. Gateways are typically custom built, configured, and used only for transmitting and receiving data between different systems. System programming through gateways is not possible within the scope of this definition.

7. Operator workstation: The central personal computer for the user to implement day to day operation of the system.

8. Router: A device for connecting different local-area network segments within a network. Routers that are used between networks with different protocols are limited. Point mapping

in this type of router is automatic and requires less than one hour to configure. This device is not capable of storing point map information.

9. TCP/IP (Transmission Control Protocol/Internet Protocol): The communication language or protocol that defines the Internet. TCP/IP can also be used as a communication protocol in private networks.

10. Terminal Unit Controller: A device to control very specific applications such as a VAV box, cabinet unit heater, fan terminal unit and the like. These units may have predefined operating sequences with limited custom programming available. (Also called an "application specific controller").

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. The HVAC Control System will consist of a flat, open architecture based upon BACNet meeting the requirement of ANSI/EIA 709.1 and ASHRAE Standard 135. Provide necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

2. The system shall operate as a low-voltage multiplexed data system. The controls and instrumentation specified herein shall be integrated and installed as a complete package by the Contractor.

3. The completed system shall be integrated such that graphics, reports, and system interfaces from the Operator's workstation appears as if there is one system.

4. No BAS system components requiring the use of gateways will be accepted.

5. To provide future flexibility, router domains shall not exceed nominally 75 percent of the maximum number of devices in the domain, unless specified otherwise.

B. Performance Requirements:

1. This section specifies the requirements for the BAS to be installed in conjunction with this project.

2. Controls contractor shall furnish and install an integrated building automation system, incorporating DDC for energy management, equipment monitoring and control, and subsystems as herein specified. Controls contractor will complete the temperature control system as specified herein.

3. Materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. Systems and components shall have been thoroughly tested and proven in actual use for at least two years.

4. Controls contractor shall be responsible for BAS and temperature control wiring for a complete and operable system. Wiring shall be done in accordance with Divisions 26, 27 and 28 of this specification and local and national codes.

5. Control and monitoring for mechanical systems installed under this Contract, including:

    a. Building ventilation systems.
    b. Building heating systems.
    c. Boiler monitoring.
    d. Chiller monitoring.
    e. Domestic hot water circulation systems.
    f. Domestic water heater monitoring.
    g. Fuel oil system monitoring.

6. The Work under this Section includes furnishing and installing wiring, conduit, connectors, terminal strips, and any other equipment required to interface each sensor or control point to the control system.

7. Provide control system and subsystem network cabling, routers, and other devices required for the systems shown and specified, except as specifically noted or shown on the drawings.

8. Providing sequences of operation described in Section 259000 - Sequence of Operations.

9. Installation of control instrumentation and hardware specified in Section 253000 - Building Automation System Field Devices, necessary for a complete system of controls.

10. Commissioning support activities as required in 019100 - Commissioning, including requirements in development of commissioning checklists, phased commissioning, trend data gathering, installation examination and performance test activities, training and IO&M requirements.

11. System functional requirements include, but are not limited to:

    a. BAS system shall provide all normal and off-normal control functionality without reliance upon PC file server or workstation.
    b. Programming information, graphics, databases, and other information required to restore the entire system in the event of equipment failure or malfunction, or human error shall be protected with a centralized back-up system.
    c. Systems shall be designed to maximize multiple-vendor flexibility to replace or modify any portion of the system.

12. Software upgrades for PC and control network operating systems, the supervisory system, web browser, programming/binding tools, etc., without limitation shall be provided at no additional charge for a period of one year after Substantial Completion of the BAS.

13. A training program shall be provided to include: Data acquisition and report generation on the Operator’s workstation.

14. The cost of providing power from the building electrical system shall be included in the bid. Power sources are subject to submittal requirements, and review and approval.

1.4 PREINSTALLATION MEETINGS

A. Coordinate installation of the building automation system with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

1.5 SUBMITTALS

A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements.

B. Product Data:

1. Provide manufacturer's literature that demonstrates compliance with the manufacturing methods, appurtenances and salient features specified.

2. Equipment tagging method specifically listing each device and the identification tag to be applied.

3. Sequence of Operations.

4. Riser Diagrams.

5. Control Diagrams.

6. Panel layouts.

7. Valve and Damper schedules.

8. Point Summary Report.

9. Blank (Reserved for Enhanced Alarm Report).

10. Blank (Reserved for Commented PPCL).

11. Blank (Reserved for Trend Logs).

12. Blank (Reserve for Electronic Plans Room file).

C. Shop Drawings:

1. Riser Diagrams.

2. Control Diagrams.

3. Panel layouts.

4. Valve and Damper schedules.

D. Quality Control Submittals:

1. Pre-functional Installation (PC) and Functional Performance Test (FT) Checklists in accordance with Section 019100 - Commissioning.

2. Incorporate BAS control requirements into the applicable equipment PC/FT checklists, including Graphic User Interface (GUI) features (provide submittal showing screen shots).

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data. The O&M Manuals will consist of the following (Progression from Submittal to O&M Manual takes place using the same binders):

1. Sequence of Operations.

2. Riser Diagrams.

3. Control Diagrams.

4. Panel layouts.

5. Valve and Damper schedules.

6. Point Summary Report.

7. Enhanced Alarm Report.

8. Commented PPCL (Program Code).

9. Trend Logs.

10. Product Data including items reused from existing control system as noted.

11. Electronic Plans Room file.

B. Warranty Documentation.

C. Record Documentation.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Companies specializing in manufacturing the products specified in this section with a minimum of three years' documented experience.

2. Installers: Minimum three years' experience in the installation, programming and start-up of building automaton systems.

3. Testing Agencies: Regulatory requirements for products requiring electrical connection – Listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the SOA.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Verify equipment and associated appurtenances are delivered in original factory packaging/crating and are free from damage and corrosion.

2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Owner.

B. Storage and Handling Requirements:

1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

1.9 WARRANTY

A. Manufacturer Warranty:

1. Provide in accordance with Section 200000 - General Mechanical Requirements.

2. Provide maximum 4 hour response time to service/warranty calls from the Owner during the warranty period.

B. Special Warranty:

1. The warranty shall consist of a commitment by controls contractor to provide, at no cost to the Owner, parts and labor as required to repair or replace such parts of the control system that prove inoperative due to defective materials or installation practices.

2. The warranty expressly excludes routine service such as instrument calibration.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Distech Controls.

B. Siemens Building Technology (SBT).

C. Johnson Controls.

2.2 APPLICATION SPECIFIC CONTROLLER (ASC)

A. General Requirements:

1. Application Specific Controllers shall be equipped with a minimum of 64K programmable non-volatile (flash) memory for general data processing, power supply, input/output modules, termination blocks, network transceivers.

2. Operating system software, custom operating sequence software and application programs shall be stored in programmable, non-volatile memory.

3. The ASC unit may be equipped with a dedicated software clock battery. If included, the battery shall be capable of maintaining time of day, day of week, date, month, and year, independent of system power for a two-week period. Include an integral calendar with automatic leap year compensation.

4. ASC packaging shall be such that complete installation and checkout of field wiring can be performed prior to the installation of electronic boards. Make board terminations by means of plug-in connectors to facilitate troubleshooting, repair and replacement.

B. ASC Interface Software:

1. General: ASC shall be configured, not programmed, via PC based interface software. This software shall be a program applet that runs within the network management tool chosen. Intimate knowledge of operation of ASC shall not be required for configuration.

2. ASC shall provide a selection of control applications performable through configuration of the device. Download of new application should not be required for one of these applications.

C. ASC Device Software:

1. General: An ASC shall operate in standalone mode as needed for specified control applications if network communication fails. Software shall include a complete operating system (O.S.), communications handler, point processing, standard control algorithms, and specific control sequences.

2. Operating system software shall reside in programmable flash memory, operate in real-time, provide prioritized task scheduling, control time programs, monitor and manage network communications, and scan inputs and outputs. The operating system shall also contain built in diagnostics.

2.3 APPLICATION GENERIC CONTROLLER (AGC)

A. General Requirements:

1. Application Generic Controllers shall be equipped with a minimum of 64K programmable non-volatile (flash) memory for general data processing, power supply, input/output modules, termination blocks, network transceivers.

2. Operating system software, custom operating sequence software and application programs shall be stored in programmable, non-volatile memory.

3. The AGC unit may be equipped with a dedicated software clock battery. If included, the battery shall be capable of maintaining time of day, day of week, date, month, and year, independent of system power for a two-week period. Include an integral calendar with automatic leap year compensation.

4. AGC packaging shall be such that complete installation and checkout of field wiring can be performed prior to the installation of electronic boards. Make board terminations by means of plug-in connectors to facilitate troubleshooting, repair and replacement. Network and power wiring shall allow for 'pass-thru' of signal when electronic boards are removed.

B. AGC Interface Software:

1. General: AGC shall be configured, not programmed, via PC based interface software. This software shall be a program applet that runs within the network management tool chosen. Intimate knowledge of operation of AGC shall not be required for configuration.

2. AGC shall provide a selection of control applications performable through configuration of the device. Download of new applications from network management tool shall be possible, but not required.

2.4 CUSTOM APPLICATION CONTROLLER (CAC)

A. General Requirements:

1. Custom Application Controllers shall be equipped with a minimum of 64K programmable non-volatile (flash) memory for general data processing, power supply, input/output modules, termination blocks, network transceivers.

2. Operating system software, custom operating sequence software and application programs shall be stored in programmable, non-volatile memory.

3. CAC unit may be equipped with a dedicated software clock battery. If included, the battery shall be capable of maintaining time of day, day of week, date, month, and year, independent of system power for a two-week period. Include an integral calendar with automatic leap year compensation.

4. CAC packaging shall be such that complete installation and checkout of field wiring can be performed prior to the installation of electronic boards. Make board terminations by means of plug-in connectors to facilitate troubleshooting, repair and replacement. The complete CAC including accessory devices such as relay, transducers, power supplies, etc. shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.

5. Equip CAC's with diagnostic indicators for the following:

a. Transmit.
b. Receive.

c. Power up test.
d. Power up fail.
e. Power up test okay.
f. Bus error.

B. CAC Software:

1. General: A CAC shall operate in standalone mode as needed for specified control applications if network communication fails. Software shall include a complete operating system (O.S.), communications handler, point processing, standard control algorithms, and specific control sequences.

2. Operating system software shall reside in programmable flash memory, operate in real-time, provide prioritized task scheduling, control time programs, monitor and manage CAC to OI communications, and scan inputs and outputs. The operating system shall also contain built in diagnostics.

3. Input/Output Point Processing Software shall include:

   a. Continuous update of input and output values and conditions. Connected points are to be updated at a minimum of one-second intervals.
   b. Analog to digital conversion, scaling and offset, correction of sensor non-linearity, sensing no response or failed sensors, and conversion of values to 32 bit floating point format. Both the maximum and minimum values sensed for each analog input are to be retained in memory. It shall be possible to input subsets of standard sensor ranges to the A/D converter and assign gains to match the full-scale 32-bit conversion to achieve high accuracy readout.
   c. A reasonability check on analog inputs against the previously read value and discard those values falling outside pre-programmed reasonability limits.
   d. Assignment of proper engineering units and status condition identifiers to analog and digital input and outputs.
   e. Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input or to assign a set of floating limits (alarm follows a reset schedule or control point) to the input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons shall be made each scan cycle.
   f. Debounce of digital inputs to prevent nuisance alarms. Debounce timing shall be adjustable from two seconds to two minutes in one second increments.

4. Alarm lockouts:

   a. Alarm lockout software shall be provided to prevent nuisance alarms. On initial start-up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Lockout period is to be programmable on a per point basis from 0 to 90 minutes in one minute increments.
   b. A “hard lockout” shall also be provided to positively lock out alarms when equipment is turned off or when true alarm is dependent on the condition of an associated point. Hard lockout points and lockout initiators are to be operator programmable.

c. Design the power supply to accommodate the power requirements of all components (or nodes) connected, plus 50 percent.

5. Run Time Totalization or Point Trending:

   a. Run time shall be accumulated based on the status of a digital input point. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Run time counts shall be resident in non-volatile memory and have CAC resident run time limits assignable through the operator's terminal.
   b. Totalized run time or trended data shall be batch downloaded using FTP to the SS on a daily or weekly basis. Trended data shall reside on the SS database server. The automatic update of this data shall be determined by the SS and facility management application requirements.

6. Transition Counting:

   a. A transition counter shall be provided to accumulate the number of times a device has been cycled on or off.
   b. Counter is to be non-volatile and be capable of accumulating 600,000 switching cycles.
   c. Limits shall be assignable to counts to provide maintenance alarm printouts.

7. Custom Direct Digital Control (DDC) Loops:

   a. Custom DDC programs are to be provided to meet the control strategies as called for in the sequence of operation sections of these specifications.
   b. Each CAC shall have residential in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences:
      1). Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and Adaptive Control (self-learning): The adaptive control algorithm shall be used on control loops, as indicated in I/O summary, where the controlled medium flow rate is variable (such as VAV units and variable flow pumping loops). The adaptive control algorithm shall monitor the loop response characteristics in accordance with the time constant changes imposed by variable flow rates. The algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of the system dynamics so that on system shutdown and restart, the learning process starts from where it left off and not from ground zero. Standard PID algorithms are not acceptable substitutes for variable flow applications since they will provide satisfactory control at only one flow rate and will require continued manual fine tuning.
      2). DDC setpoints, gains and time constants associated with DDC programs shall be available to the operator for display and modification via the SS operator interface.
      3). The execution interval of each DDC loop shall be adjustable from 2 to 120 seconds in one-second increments.
      4). DDC control programs shall include an assignment of initialization values to outputs to assure that controlled devices assume a fail-safe position on initial system start-up.

2.5 VAV CONTROLLERS

A. Provide manufacturer's thermostat matched to controller. Refer to Section 253000 - Building Automation System Field Devices, for requirements.

B. Coordinate with Section 233600 - Air Terminal Units to have VAV controllers factory mounted on the VAV terminal unit.

2.6 ROUTERS, BRIDGES, REPEATERS AND TRANSCEIVERS

A. Routers, Bridges and Repeaters:

1. Equip each router and bridge with a network transceiver on each network port (inbound and outbound) as dictated by the network type (Type 1 - FTT, Type 2 - TP, Type 3 - PL, Type 4 - LP, Type 5 - RF).

2. The network router shall be designed to route messages from a segment, sub-net, or domain in full duplex communication mode.

3. Routers with TCP/IP capability shall be provided where TCP/IP backbone is used.

4. Routers, bridges and repeaters shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions.

5. The routers, bridges, and repeaters shall be capable of DIN rail or panel mounting and be equipped with status LED lights for Network traffic and power.

B. Transceivers:

1. Type 1 Network Transceiver, Free Topology, Twisted Pair: Provide a transformer isolated, twisted pair transceiver capable of mounting directly on a printed circuit board. The transceiver shall meet the following specifications:

   a. Differential Manchester encoded signaling for polarity insensitive network wiring.
   b. Transformer isolated for common mode rejection.
   c. 78 Kbps network bit rate up to distances of 2000m.
   d. Free topology supports star, home run, multi drop and loop wiring topologies.
   e. Complies with FCC and VDE requirements.
   f. UL recognized component.

2. Type 2 Network Transceiver, Twisted Pair: Provide a transformer isolated twisted pair transceiver capable of mounting directly on a printed circuit board. The transceiver shall meet the following specifications:

   a. Differential Manchester encoded signaling for polarity insensitive network wiring.
   b. Transformer isolation for common mode rejection.
   c. 1.25 Mbps network bit rate up to distances of 1000 meters.
   d. Unpotted construction.
   e. Less than 1 mA power consumption with +5VDC input voltage.
   f. FCC and VDE Level B requirements compliance.

g. UL Listed.

3. Type 3 Network Transceiver, Power Line:

   a. Provide a direct sequence, spread spectrum power line transceiver which is equipped with the following signal processing and error correction capabilities to provide robust and error free communications.
      1). Forward Error Correction (FEC) to enable the system to read and reconstruct corrupted packets without sacrificing throughput. The FEC shall require only six percent overhead for error correction.
      2). Automatic sensitivity adjustment algorithm that dynamically changes the receiver sensitivity based on noise characteristics.
      3). Oversampling correlation filter and adaptive data recovery algorithm to synchronize instantaneously to incoming packets.
      4). Tri-state power amplifier/filter combination to provide a powerful output signal with a minimum number of components.

   b. The transceiver shall be able to operate using the controller power supply and coupling circuit. Provide the following general features as a minimum:
      1). Packaged in a rugged, potted module.
      2). Programmable clock output (1.25, 2.5, 5 or 10 Mhz).
      3). 10 Kbps network transmission rate.
      4). Packet detect output to drive a status indicator LED.
      5). Minus 20 to plus 85 degrees C. operating temperature range.
      6). UL Listed.

4. Type 4 Network Transceiver, Link Power: Provide a twisted pair transceiver that utilizes the twisted pair communication media to provide power for Controller(s). The transceiver shall meet the following specifications:

   a. Free single-in-line package (SIP) construction.
   b. Send both network data and power on a twisted wire pair.
   c. Differential Manchester encoded signaling for polarity insensitive network wiring.
   d. 78 Kbps network bit rate up to distances of 320 meters.
   e. Supports star, home run, multidrop, and loop wiring.
   f. Supplies +5VDC @ 100 mA maximum for node power.
   g. Compliance with FCC and VDE requirements.
   h. UL Listed.

5. Type 5 Network Transceiver, Radio Frequency: Provide a direct sequence, spread spectrum RF transceiver that meets the following specifications:

   a. 100 meter open field range.
   b. Wireless communications extends network between buildings and to vehicles and portable devices.
   c. FCC type certifiable, 48 MHz.
   d. Low-cost miniature circuit board, SMT components.
   e. Carrier detect output to drive a status indicator LED.
   f. Plus 7 to plus 15VDC input voltage.
   g. Minus 20 to plus 60 degrees C. operating temperature range.

2.7 OPERATOR WORKSTATION

A. Laptop computer for the user to implement day to day operation of the system. The laptop is generally capable of allowing the operator to accomplish the following functions:

1. Operate in a network environment.
2. Monitor the entire control system.
3. Change set points.
4. Maintain, set, and monitor alarms.
5. Maintain and monitor operating schedules.
6. Control interactively using graphical representations of the system.
7. Manually command points.
8. Trend the behavior of selected points.
9. Archive history.
10. Backup data.
11. Print results.
12. Modify custom programs and sequences of operation.

2.8 LAPTOP COMPUTER (OPERATOR WORKSTATION) HARDWARE

A. A new graphical laptop computer (operator workstation) shall be provided as specified in this section. The new workstation shall communicate directly with the existing controls database server. Communication shall take place over the Owner's existing Wide Area Network. Programming, graphics and databases created as part of this project shall be incorporated into the existing controls system. Provide a complete, secure backup of the host database at the completion of this project.

B. Provide one graphical laptop computer for command entry, information management, network alarm management and database management functions. The laptop shall communicate seamlessly with the existing controls system.

1. Provide one workstation of equal or greater capability, with the ability to connect to the network in each mechanical space in the building.
2. Workstation shall consist of a laptop computer with minimum 16GB RAM, 15" screen, hard drive with minimum 1 TB available space and wireless mouse. Laptop computer shall be Windows compatible.

2.9 WORKSTATION OPERATOR INTERFACE

A. Basic Interface Description:

1. Operator workstation interface software shall minimize operator training through the use of English language prompting, 30-character English language point identification, on-line help, and industry standard PC application software. Interface software shall simultaneously communicate with up to 4 Building Level Networks and share data between any of the 4 networks. The software shall provide, as a minimum, the following functionality:

    a. Real-time graphical viewing and control of environment.
    b. Scheduling and override of building operations.
    c. Collection and analysis of historical data.
    d. Point database editing, storage and downloading of controller databases.
    e. Alarm reporting, routing, messaging, and acknowledgment.
    f. Display dynamic data trend plot.
    g. Definition and construction of dynamic color graphic displays.
    h. Program editing.
    i. Transfer trend data to third party software.
    j. Scheduling reports.
    k. Operator Activity Log.

2. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device and “point and click” approach to menu selection.

3. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information.

4. Operator specific password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall “follow” the operator to any workstation logged onto (up to 999 user accounts shall be supported).

5. Scheduling and Override: Provide a calendar type format for simplification of time-of-day scheduling and overrides of building operations. Schedules reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line, PC is not required to execute time scheduling. Provide override access through menu selection or function key.

6. Collection and Analysis of Historical Data: Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

B. Dynamic Color Graphic Displays:

1. Create at least one color graphic display for each piece of mechanical equipment, including air handling units, hot water boiler systems, and room level terminal units. Provide floor plans to facilitate navigation. Point information to be displayed on the graphics shall be provided by the BAS contractor to optimize system performance and analysis and to speed alarm recognition.

2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands. Graphics software shall permit the importing of submittal AutoCAD drawings and scanned pictures for use in the system.

3. Dynamic temperature values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.

4. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.

5. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

6. A dynamic display of the site-specific architecture showing status of controllers, PC workstations and networks shall be provided.

C. System Configuration and Definition:

1. Network wide control strategies shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.

2. Provide automatic backup and restore of DDC controller databases on the workstation hard disk. In addition, database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity.

D. Alarm Management:

1. Alarm Routing shall allow the user to send alarm notification to selected PC locations based on time of day, alarm severity, or point type.

2. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message. The alarm display shall provide a mechanism for the operator to sort alarms.

3. Alarm messages shall be customizable for each point to display detailed instructions to the user regarding actions to take in the event of an alarm.

2.10 NETWORKING COMMUNICATIONS

A. The design of the BAS shall network an operator workstation(s) and stand-alone DDC Controllers. The network architecture shall consist of three levels; a Management Level Network (MLN) Ethernet network based on TCP/IP protocol, a high performance peer-to-peer building level network (BLN) and DDC Controller floor level local area networks (FLN). Access to the system shall be totally transparent to the user when accessing data or developing control programs.

B. Management Level Network:

1. PCs shall simultaneously direct connect to the Ethernet and Management Level Network without the use of an interposing device.

2. The Management Level Network shall not impose a maximum constraint on the number of operator workstations.

3. Simultaneous user access to network limited to number of sight licenses issued to user.

4. When appropriate, any DDC controller residing on the peer-to-peer building level network shall connect to Ethernet network without the use of a PC.

5. Any PC on the Ethernet Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet as well as directly connected building level networks. Any PC shall be able to interrogate any controller on the building level network in addition to being able to download program changes to individual controllers.

6. The Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3.

7. Access to the system database shall be available from any client workstation on the Management Level Network.

C. Peer-to-Peer Building Level Network (BLN):

1. The system shall have the ability to support integration of third party systems (fire alarm, security, lighting, variable speed drives, PLCs, condensers, boilers) via a panel mounted open protocol processor. This processor shall exchange data between the two systems for inter-process control. Exchange points shall have full system functionality as specified herein.

2. Data transfer via Ethernet.

D. Floor Level Network (FLN):

1. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data.

2.11 CONTROL PANELS

A. Terminal Equipment Controllers will be mounted in enclosed control panels with screwed, removable covers.

B. Control devices located in exposed areas subject to outside weather conditions or near circulator pumps (spray due to shaft seal failures) shall be mounted inside weatherproof enclosures. Location of each panel shall be convenient for adjustment service.

C. Nameplates shall be provided beneath each panel face mounted control device describing the function of each device. Nameplates shall have white letters engraved on blue Lamicoid, or approved equal.

D. Control panels shall bear a UL label compatible with the application.

E. Electrical devices within the panel shall be pre-wired to terminal strips, with inter-device wiring within the panel completed prior to installation of the system.

F. BLN level controllers shall be provided with standby/emergency power to provide power quality and minimum 15 minutes operation.

2.12 UNINTERRUPTIBLE POWER SUPPLY

A. Acceptable manufactures are limited to the following:

1. Powerware.

2. Alternate Brand Request or Substitution Request required.

2.13 ACCESS PANELS

A. Access panels provided by Division 08.

B. Coordinate access panel location with the Owner’s Representative and Division 08. Provide access to concealed control devices.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Special Techniques:

1. Mount damper operators and other control devices secured to insulated ductwork on brackets such that the device is external of the insulation. See Section 200529 - Hangers and Supports.

2. Do not install control devices in locations where they are subject to damage or malfunction due to normally encountered ambient temperatures.

3. Identification: Permanently tag controllers, switches, relays, thermostats and actuators for identification using the tagging format shown on the BAS control drawings.

4. Sensors and Switches:

   a. Pump flow or fan flow, etc., shall be sensed using current switch unless indicated otherwise. Calibrate current switch to distinguish between loaded or unloaded motor condition due to belt or coupler breakage.
   b. Protect averaging or capillary tubes where they penetrate duct with rubber grommet and seal with clear silicon. Support with capillary clips and maintain minimum 1 inch tubing bending radius.

5. Wiring:

   a. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. Install wiring in exposed or inaccessible areas in EMT conduit. Plenum-rated cable may be used in concealed, accessible areas only.
   b. Provide wiring between thermostats and unit heater motors, and control and alarm wiring.
   c. Provide conduit and wiring between the BAS panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring in conduit or plenum-rated cable.
   d. Provide conduit and control wiring for devices specified in this Section.
   e. Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in BAS panels located in the vicinity of motor control centers.
   f. Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contactors, and BAS panels, as shown on the drawings or as specified.
   g. Wiring shall be compliant with the Divisions 26, 27 and 28 requirements and the NEC.
   h. Provide electrical wall boxes and conduit sleeves for wall-mounted devices. Mount thermostats at 48 inches AFF unless otherwise noted.

B. Interface with Other Work:

1. The Contractor is responsible to furnish and install complete and operational systems. The following breakdown is recommend; carefully coordinate work between subcontractors.

2. Products furnished by BAS contractor for installation by the mechanical contractor:

   a. Control valves.
   b. VAV box controllers.
   c. Wells for hydronic temperature sensors.

3. Products furnished and installed by mechanical contractor:

   a. VAV boxes: BAS contractor shall furnish VAV box controls to the VAV box manufacturer for factory installation at the expense of the box manufacturer.
   b. VAV box controller enclosures will be provided by box manufacturer.

c. Gauges, thermometers and thread-o-lets for BAS contractor furnished control sensor wells.
d. Airflow measuring stations.
e. Control and balancing dampers.
f. Smoke and fire/smoke dampers actuators.

4. Electrical contractor (Div. 26, 27, 28) provides:

a. Wiring of power feeds through disconnect starters to electrical motors.
b. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by controls contractor.
c. Duct smoke detectors including installation and wiring.
d. Power wiring of smoke/fire dampers provided by Divisions 20, 21, 22, 23, 25.
e. Stand-alone packaged controls and wiring of stand-alone packaged controls to their remote sensors and devices.
f. Ethernet drop at or near designated BAS control panel(s).
g. Mounting and wiring of Variable Speed Drives (VSDs) furnished by the Mechanical Contractor per Divisions 20, 21, 22, 23, 25.

C. System Integration. Products to receive integration under this section:

1. Variable Speed Drives:

a. Connect directly to the BAS through three twisted pair for Start/Stop, speed control and remote communications.
b. Factory-furnished with the appropriate communication hardware and software to allow communication.
c. Connections to VSD provided under this section.

2. Fire Alarm/Life Safety System:

a. The BAS shall communicate with the fire alarm/life safety system via an alarmable point in the form of a dry contact.
b. The device will be provided and terminated by Divisions 26, 27 and 28. This section will provide wiring to the termination device.

3.2 PROGRAMMING

A. Programming and graphics shall be included to implement the controls sequences specified in Section 259000 - Sequence of Operations, and to implement the systems and features included in Facility Services Divisions 20-28. It shall not be necessary for the Contracting Agency to further program the system.

B. Provide licensed copies of software tools and programming aids used to install, develop and troubleshoot the controls system to the Contracting Agency. Assist the Contracting Agency in registering the software in Contracting Agency’s name.

C. Implement the control sequences for the equipment on this project as contained in Section 259000 - Sequence of Operations.

D. Point identifiers shall be chosen for easy identification of the actual equipment being controlled or monitored. They shall include equipment tag identifiers shown on the drawings, and may

include additional characters to identify floor, area, etc. Maintain a listing of identifiers used in this project, with their plain English names. Submit the listing for review and information.

3.3 GRAPHICS

A. Graphical Mechanical Displays: Create graphical displays of major mechanical equipment for this project and install graphics on the PC-based workstations. At a minimum, these graphical displays shall include building floor plans derived from architectural AutoCAD representations and graphical representations of the equipment controlled under this contract.

1. Plans:
   a. Provide a central site plan for the entire facility and immediate surroundings. As a minimum indicate the following:
      1). Area designation.
      2). Number of levels on each area.
      3). Adjacent street names.
      4). North arrow.
   b. Provide floor overall floor plans for each level of the facility. As a minimum indicate the following:
      1). Area designation and level.
      2). Mechanical and electrical rooms.
      3). Control panel locations.
      4). North arrow.
   c. Provide individual floor plans for the facility. As a minimum indicate the following:
      1). Walls, doors, and general floor plan arrangement.
      2). Mechanical and electrical rooms.
      3). Temperature sensors.
      4). Temperature control zones.
      5). Control panel locations.
      6). North arrow.
      7). List of major HVAC systems serving the area including but not limited to the following:
         a) Air handling systems.
         b) Exhaust fans.
         c) Toilet exhaust fans.
         d) Heating systems.
         e) Cooling systems.
   d. As a minimum provide the following functional links on for each floor plan:
      1). Provide links back and forth between the plan screens noted above.
      2). On floor plan with temperature sensor, provide dynamic color coding for each sensor as follows:
         a) Blue indicates space temperatures less than 65 degrees F.
         b) Green indicates space temperatures between 66 degrees and 74 degrees F.
         c) Red indicates space temperatures above 75 degrees F.
      3). Provide a link to each VAV terminal unit from the associated temperature sensor.
      4). Provide a link to each major mechanical system serving the temperature sensor.

2. Room Reheat coils:
   a. Indicate the following information for each unit:

1). Room Temperature.
2). Coil valve position percent.
3). Terminal heating unit valve position percent.

3. Air Handling: Indicate the following information for each AHUs/MAUs, relief/exhaust fans, and toilet exhaust fans:
   a. Put control points and adjustable set points on the screen.
   b. Define action of dampers and valves (N/O or N/C);
   c. Fan schedule override commands.
   d. Reset schedules.
   e. Outside air CFM and minimum requirement.
   f. Duct static set point.

4. Building static pressure: Provide a common screen for the building and fan room static pressure sensors for the entire facility. Put control points, adjustable set points, and reset schedules on the screen.

5. Boiler Room: Indicate the following information for the heating pumps, boiler room ventilation equipment, and other boiler room equipment:
   a. Put control points and adjustable set points on the screen.
   b. Define action of dampers and valves (N/O or N/C).
   c. Pump override commands.
   d. Boiler override commands.
   e. Reset schedules.
   f. GPM flows.
   g. Outside air temperature.

B. Graphical Electrical Displays: Create graphical displays of electrical equipment specified for connection to this system. Coordinate with Divisions 26, 27 and 28 and provide graphics on the PC-based workstations. At a minimum, these graphical displays shall include building floor plans utilized for Graphical Mechanical Displays.

1. Emergency/Standby Generating System:
   a. Operating parameters, generation equipment and ATS status, and alarm information.
   b. Refer to Section 263213 - Diesel Engine Driven Generator Sets, for additional information.

2. Building Lighting Control:
   a. Status information.
   b. Put control points and adjustable set points on the screen.
   c. Lighting override commands.

3. Site Lighting Control:
   a. Status information.
   b. Put control points and adjustable set points on the screen.
   c. Lighting on/off override commands.

C. Use approved designations for room names, spaces, equipment tags, etc.

3.4 SITE QUALITY CONTROL

A. Document each installation and operational step utilizing the approved PC/FT checklists in accordance with Section 019100 - Commissioning.

B. Programming BAS to provide system operation and monitoring in accordance with Section 259000 - Sequence of Operation and other referenced sections.

C. Trend Logs:

1. Prepare trend logs for all points required to demonstrate BAS calibration, control and stability.

2. Trend logs shall document building operation after applicable PC/FT checklists are completed and building site commissioning is satisfactorily completed.

3. Set points, valve positions, etc. may be temporarily adjusted to artificially induce the intended sequences to occur.

3.5 CLOSEOUT ACTIVITIES

A. Demonstration:

1. Provide demonstrations in accordance with Section 017900 - Demonstrations and Training.

2. Demonstrate the proper operation and control of systems controlled and monitored by the BAS.

3. The demonstration shall include, but not necessarily be limited to, the following:

a. Review of the Trend Logs.
b. Complete and proper operation of control systems including simulations.
c. Access to devices for required maintenance.
d. Review of associated graphics on Host.

B. Training:

1. Provide training in accordance with Section 017900 - Demonstrations and Training.

2. In addition, provide 40 hours of on-site instruction by BAS contractor to familiarize operating personnel with the control system. Instructions will include:

a. A brief description of the controls' sequence of operation.
b. A discussion and explanation of alarms, switches and gauges.
c. A summary and explanation of steps to be taken in response to specific alarms or control malfunctions.
d. Building walk-through to physically locate and examine control devices and demonstrate control setpoint adjustment procedures.

e. Instructions regarding adjustment procedures shall emphasize methods for continual building "fine-tuning".

END OF SECTION 255000

SECTION 259000 - SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section describes the building automation system (BAS) control sequences for the heating, ventilating and air-conditioning (HVAC) systems, electrical systems and plumbing systems provided for this project.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 211000 - Water Based Fire Suppression Systems
4. 230593 - Testing, Adjusting and Balancing
5. 232123 - Hydronic Pumps
6. 233100 - Ducts and Accessories
7. 233400 - HVAC Fans
8. 233600 - Air Terminal Units
9. 235223 - Cast Iron Boilers and Accessories
10. 236400 - Packaged Water Chillers
11. 237323 - Central Air Handling Units
12. 238123 - Dedicated Air-Conditioning Units
13. 238200 - Terminal Heating and Cooling Units
14. 238316 - Radiant Floor Heating Equipment
15. 253000 - Building Automation System Field Devices
16. 254000 - Variable Speed Drives
17. 255000 - Building Automation System
18. 281600 - Security Alarm and Detection

19. 283100 - Addressable Fire Alarm

1.2 SUBMITTALS

A. Refer to 200000 – Mechanical General Requirements.

B. Product Data:

1. Provide BAS manufacturers' product literature, clearly annotated to indicate performance criteria to include the following:

a. Building level to floor level network controller riser diagrams. Include building locations and equipment controlled by each controller.
b. Sequences of operation for HVAC, electrical and plumbing systems.
c. Process control diagrams to support each sequence of operation. Show field mounted control device locations and circuit routing.
d. Complete electrical BAS points list.

C. Quality Assurance/Control Submittals:

1. Installation and Functional Performance Test Letter.

a. Provide a letter certifying that the building automation system hardware is completely installed and sequences of operation have been programmed, operationally tested, with physical verification, to comply with the sequences of operation as specified. The installer(s), sub-contractor(s) and the Contractor must sign the letter.
b. Include as an attachment, a list of programming deviations from the specified sequences of operation with justification to support each deviation.
c. Include as an attachment, a table of final adjustable setpoint values for each applicable control point.

D. Installation, Operation and Maintenance Data:

1. Refer to Section 200000 – Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.

2. Provide approved submittal information, revised to reflect the actual installation as addressed in the attachments provided with the Installation and Functional Performance Test Letter, for inclusion within the project IO&M Manual.

1.3 QUALITY ASSURANCE

A. Qualifications of Installers/Programmers: Minimum 3 years' experience in the installation and programming of direct digital control systems.

B. Pre-Installation Meetings: Conduct coordination meetings, as necessary, to evaluate and coordinate the connection of the BAS to each piece of HVAC, electrical and plumbing equipment. Where the BAS is to be connected to packaged, stand-alone controllers, coordinate

BAS remote control and monitoring capabilities with the specific features of the packaged controller to maximize remote operability and monitoring of each packaged controller through the BAS.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Setpoints, schedules, offsets, and delays described in the sequences of operations shall be adjustable.

B. Electrical Load Sequencing:

1. Limit starting surge on emergency generator by sequencing controlled motors “ON”, one at a time at not less than five second intervals.

2. Limit motors controlled by variable speed drives to 80 percent of full load when operating on generator power.

C. Emergency Generator Monitoring:

1. Run status.

2. Total run time.

3. Common pre-alarms (any alarm condition that does not prevent the generator from running.

4. Common alarms (any alarm condition that prevents the generator from running).

5. Battery charger fault.

D. Emergency Generator Alarm: Provide alarm if generator runs more than 60 minutes at any one time.

3.2 FIRE ALARM PANEL MONITORING

A. Monitor the building fire alarm panel alarm status output.

3.3 VENTILATION SYSTEMS (AHU-1 THROUGH AHU-3)

A. General Ventilation System Description:

1. The forced air ventilation system for the clinic consists of 4 centralized air handling units (AHU) located in 2 second floor Fan Rooms (201 and 211). The air handling units serve the following areas.

   a. AHU-1: Clinic Areas.
   b. AHU-2: Wellness Area.
   c. AHU-3: Administration Areas.
   d. AHU-4: Dental Area (See Article 3.4).

2. AHUs utilize a variable air volume (VAV) control strategy incorporating variable speed drive motor controllers to modulate supply fan speed. During periods of low system demand, supply fans automatically reduce speed, minimizing fan horsepower and conserving electrical energy.

3. Supply air from AHUs is transferred to their respective variable air volume (VAV) terminal units through a system of medium pressure ductwork. Each VAV terminal unit, with hydronic reheat coil, controls supply airflow rate (CFM) and temperature to maintain zone setpoint temperature. Auxiliary fintube or radiant ceiling panel heating is provided for each perimeter zone to improve comfort.

4. Return air from AHU's flows back through return ducting to the AHUs. Once back at the AHUs, return air is either re-circulated through the building, or is relieved from the building through relief dampers in the AHU.

B. Typical AHU Ventilation System Operation:

1. Full Shutdown Mode:

   a. AHU:
   b. Supply fans off.
   c. Return fans off.
   d. Mixing box outside air damper shut.
   e. Mixing box return air damper fully open.
   f. Return fan relief damper shut.
   g. Heating coil circulation pumps (PMP-7A/-7B, PMP-8A/-8B, PMP-9A/-9B) enabled and heating coil hydronic control valve modulating to maintain 55 degrees F minimum mixing box air temperature.
   h. Cooling coil hydronic three-way control valves shut (no flow through coil).

2. Start Sequence:

   a. Provide independent, adjustable, automatic start/stop sequence for each air handling system based on time-of-day schedule.
   b. Provide a minimum 5-second time delay between the start of each AHU supply fan and return fans.

c. AHU-1 to operate 24/7 to maintain required room pressure relationships and allow adequate indoor air quality for medical staff staying overnight in bunk area on the second level.

3. Supply Fan Speed Control:

   a. Locate duct static pressure sensors in main supply air duct, approximately 3/4 the distance between the AHU supply outlet and most remote zone variable air volume (VAV) terminal unit branch duct connection. In systems with multiple supply air duct branches, provide a separate static pressure sensor in each main branch duct, located approximately 3/4 of the distance between the AHU supply outlet and the most remote zone terminal unit branch connection. Suggested locations are shown on the drawings.
   b. Utilizing the fan variable speed drive (VSD) controller, modulate supply fan speed to maintain the lowest branch duct static pressure at 1.5 inches WC setpoint pressure.
   c. Program AHU to go into Full Shutdown Mode in the event of VSD failure. Require manual restart of the system.

4. Return Fan Speed Control:

   a. Locate static pressure sensor in return fan discharge plenum upstream of the mixing box.
   b. Modulate the return fan speed through the variable speed drive (VSD) controller to maintain a discharge pressure of 0.2 inches WC setpoint pressure.

5. Building Static Pressure Control:

   a. Provide two outdoor ambient pressure sensors on the roof on opposite corners of the building as shown on the drawings.
   b. Provide indoor static pressure reference heads in the following locations:
      1). Circulation (120) - AHU-1
      2). Breakroom (212) - AHU-1
      3). Circ Wellness (112) - AHU-2
      4). Circulation (104) - AHU-3
      5). Waiting (200B) - AHU-3

   c. Compare indoor static pressure reference heads for each AHU with the average reading from the outdoor ambient pressure sensors. Modulate each AHU relief damper to maintain a positive 0.03 inches WC building pressure as measured by its respective indoor static pressure head(s).

6. Supply Temperature Control:

   a. Pre-Occupancy Warm-Up/Cool-Down Mode:
      1). Initial Conditions: The ventilating system is in Full Shutdown Mode.
      2). Initiate pre-occupancy warm-up/cool-down cycle one hour prior to scheduled Occupied Mode operation.
      3). Start AHU using the start sequence.
      4). Control AHU fan speeds using fan speed control sequence.

5). Warm-Up: Enable heating coil circulation pumps (PMP-7A/-7B, PMP-8A/-8B, PMP-9A/-9B) and modulate heating coil hydronic control valve to maintain 55 degrees F supply air setpoint temperature as measured downstream of supply fan. The outside air damper remains shut, the return air damper remains fully open, and the relief damper remains shut. The building pressure control sequence is disabled.
6). Economizer Cool-Down: If outdoor air temperature is greater than 45 degrees F and less than 65 degrees F, modulate outside air damper open and modulate return air damper shut to maintain 55 degrees F supply air setpoint temperature. The relief damper modulates to maintain an approximately neutral building pressure.
7). Mechanical Cool-Down: If outdoor air temperature is greater than 65 degrees F, the outside air damper remains shut, the return air damper remains fully open, and the relief damper remains fully shut. Modulate open hydronic cooling control valve to maintain supply air setpoint temperature.

b. Occupied Mode:
1). System has completed Pre-Occupancy Warm-Up/Cool-Down Mode and zones are at Occupied Mode temperature setpoints.
2). Command outside air damper to occupied mode from the BAS. Outside air damper modulates open and controls minimum outside air volume flow rate (CFM) to scheduled value as measured by the airflow measuring station.
3). Return air damper modulates proportionally to outside air damper.
4). Relief damper modulates to maintain building static pressure.
5). Measure mixing box mixed air temperature using duct averaging flexible sensors. If mixed air temperature is less than 55 degrees F setpoint shift to Heating Mode. Enable heating coil circulation pump and modulate heating coil hydronic control valve to maintain 55 degrees F supply air setpoint temperature measured downstream of supply fan.
6). If mixed air temperature is greater than 55 degrees F setpoint, and the heating coil hydronic control valve has been shut for 3 minutes, shift to Economizer Cooling Mode. Modulate open outside air damper and modulate shut return air damper proportionally to maintain supply air temperature setpoint. Modulate relief damper to maintain building static pressure.
7). If the outside air damper is fully open and return air damper is fully shut for 5 minutes, supply air temperature is greater than setpoint temperature, and the outside air temperature increases to 5 degrees F greater than return air temperature, shift to Mechanical Cooling Mode. Modulate the outside air damper to the minimum outside air position. Modulate return air damper open and modulate relief damper to maintain building static pressure setpoint. Modulate cooling coil hydronic control valve to maintain supply air temperature setpoint.

c. Unoccupied Mode:
1). AHUs are initially operating in Occupied Mode.
2). Shift ventilation systems to Full Shutdown Mode.
3). The hydronic heating system operates to maintain 65 degrees F night setback temperature setpoint plus 3, minus 0 degrees F using perimeter heat only.
4). If any zone falls below setback temperature setpoint, operate the applicable ventilating system using Pre-Occupancy Warm-Up Mode sequences.

5). Provide 15-minute minimum supply fan run time and 5-minute minimum system off time.
6). If any thermostat occupancy override button is pushed, operate that ventilation system in Occupied Mode for a 2-hour period.

C. Typical Zone VAV Temperature Control with Reheat:

1. Zone Sensors: Provide wall-mounted zone thermostat with input to zone VAV terminal equipment controller.

2. Occupied Mode Operation:

a. Heating Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Modulate VAV reheat coil control valve in parallel with control damper.
b. Cooling Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Cooling CFM to maintain zone day setpoint temperature, plus or minus 1-degree F. Reheat coil control valves remain shut.

3. Unoccupied Mode Operation:

a. Heating Mode: When AHU is operating, modulate VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone night setpoint temperature plus 0, minus 3 degrees F. Modulate VAV reheat coil control valve in parallel with control damper.
b. Cooling Mode: Ventilation system remains off regardless of zone temperature.

D. Typical Zone VAV Temperature Control with Reheat and Auxiliary Heat (Fintube or Radiant Panel):

1. Zone Sensors: Provide wall-mounted zone thermostat with input to zone VAV terminal equipment controller.

2. Occupied Mode Operation:

a. Heating Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Modulate reheat coil and auxiliary heat control valves in parallel with control damper.
b. Cooling Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Cooling CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Reheat coil and auxiliary heat control valves remain shut.

3. Unoccupied Mode Operation:

a. Heating Mode: When AHU is operating, modulate VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone night setpoint temperature plus 0, minus 3 degrees F. Modulate VAV reheat coil and fintube control valves in parallel with control damper.
b. Cooling Mode: Ventilation system remains off regardless of zone temperature.

E. Laundry - Clean (152) VAV Temperature and Room Pressure Control:

1. Zone Sensors:

a. Zone Thermostat: Provide wall-mounted zone thermostat with input to zone VAV terminal equipment controller.
b. Zone Pressure Sensing: Provide ceiling-mounted static pressure reference heads and differential pressure transmitter as shown on the drawings, with input to zone VAV terminal equipment controller.

2. Occupied Mode Operation:

a. Heating Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Modulate reheat coil control valve in parallel with control damper.
b. Cooling Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Cooling CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Reheat coil control valve remains shut.

3. Unoccupied Mode Operation:

a. Heating Mode: When AHU is operating, modulate VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone night setpoint temperature plus 0, minus 3 degrees F. Modulate VAV reheat coil control valve in parallel with control damper.
b. Cooling Mode: Ventilation system remains off regardless of zone temperature.

4. Room Pressure Control:

a. Room is required to be positively pressurized with respect to adjacent corridor. Room contains a commercial clothes dryer with periodic exhaust ventilation. Make-up air for the commercial clothes dryer is provided by the room VAV box.
b. Dryer not in use: Operate VAV box in Occupied Mode to maintain zone temperature setpoint and to maintain a minimum positive 0.03 inches WC pressure.
c. Dryer in use: Modulate VAV box control damper open to maintain a minimum positive 0.03 inches WC. Modulate reheat coil control valve to maintain the zone temperature setpoint.
d. Coordinate with testing, adjusting, and balancing contractor to provide supply and exhaust airflow offset to maintain room differential setpoint, with and without dryer operating.
e. If room differential pressure setpoint drops below 0.01 inches WC for more than 30 seconds, generate “Clean Room Low Pressure” alarm to the BAS.

F. Safety Shutdowns:

1. General:

a. “Hardwire” system safety shutdowns to provide safe, reliable operation in the event of Building Automation System (BAS) failure.

b. Where equipment is provided with packaged stand-alone controls, capable of operating the equipment independently from the BAS, provide control logic which shifts the equipment to stand-alone operation in the event of BAS failure.

2. Return Duct Smoke Detector Shutdown:

a. Hardwire return air duct smoke detectors directly to the building's fire alarm panel. Refer to Section 283100 - Addressable Fire Alarm System for sequence of operation.
b. Monitor fire alarm panel "General Alarm" status from BAS system.
c. On "General Alarm" from fire alarm panel, the BAS shall:
   1). Verify AHU supply and return fans are off. If fans are operating, stop supply and return fans.
   2). Shut outside air dampers.
   3). Open return air dampers.
   4). Shut relief dampers.
   5). Stop exhaust fans and shut exhaust fan dampers.

3. High Duct Static Pressure Shutdown:

a. If ventilating system duct supply static pressure increases to 3.0 inches WC:
   1). Command applicable ventilating system to Full Shutdown Mode.
   2). Provide "AHU-X High Static Pressure" alarm.
   3). Require manual restart of the ventilation system through the BAS.

4. Low Temperature Shutdown:

a. If supply air temperature decreases to 45 degrees F:
   1). Command applicable ventilating system in Full Shutdown Mode.
   2). Provide "AHU-X Low Temperature Shutdown" alarm.
   3). Require manual restart of the ventilation system through the BAS.

G. Maintenance and Alarm Monitoring:

1. Air filter replacement monitoring:

a. Provide analog differential pressure sensor at each pre-filter bank:
   1). Normal filter (MERV-8) differential pressure range is 0.27 inches WC (clean) to 0.90 inches WC (dirty) at 500 feet per minute.
   2). Generate "AHU-X High Filter Differential Pressure" maintenance alarm at 0.80 inches WC.

b. Provide analog differential pressure sensor at each final filter bank:
   1). Final filter (MERV-14) differential pressure range is 0.32 inches WC (clean) to 1.00 inches WC (dirty).
   2). Generate "AHU-X High Filter Differential Pressure" maintenance alarm at 0.90 inches WC.

2. Zone Temperature Monitoring:

a. Generate “AHU-X Zone Temperature High/Low” maintenance alarm if any zone temperature is not being maintained within setpoint band tolerance as described in Occupied Mode and Unoccupied Mode sequences.
b. During optimized start period, generate “AHU-X Zone Temperature High/Low” maintenance alarm if any zone temperature fails to meet occupied temperature setpoint.
c. Generate “AHU-X Zone Low Temperature” critical alarm if any zone temperature falls below 55 degrees F.

3. Duct Static Pressure Monitoring:

a. Generate “Duct Static Pressure High/Low” maintenance alarm if duct pressure falls outside setpoint tolerance, plus or minus 0.05 inches WC.
b. Provide 3-minute alarm time delay to prevent spurious alarms.

4. AHU Flow Monitoring:

a. Provide BAS monitoring of variable speed drive enable/disable contacts, analog speed controller, and trouble contacts.
b. Generate “VSD Fault” alarm if the VSD fan motor controller goes into fault.

3.4 VENTILATION SYSTEM (AHU-4)

A. General Ventilation System Description:

1. The forced air ventilation system for the dental area within the clinic consists of a single once-through centralized air-handling unit (AHU) located in the second floor Fan Room 211.

2. AHU-4 utilizes a variable air volume (VAV) control strategy incorporating variable speed drive motor controllers to modulate supply and exhaust fan speeds. During periods of low system demand, supply and exhaust fans automatically reduce speed, minimizing fan horsepower and conserving electrical energy.

3. Supply air from AHU-4 is transferred to its respective variable air volume (VAV) terminal units through a system of medium pressure ductwork. Each VAV terminal unit, with hydronic reheat coil, controls supply airflow rate (CFM) and temperature to maintain zone setpoint temperature. Auxiliary radiant ceiling panel heating is provided for each perimeter zone to improve comfort.

4. Exhaust air is controlled by exhaust air valves within the dental area in order to maintain proper room pressure relationships. Exhaust air from the zones flows back through exhaust ducting to the AHU. Once back at the AHU, exhaust air passes through a heat recovery coils (RC-4A and RC-4B) to transfer heat from the exhaust air (RC-4B) to the incoming outside air (RC-4A) and is then relieved from the building by the exhaust fan.

B. Ventilation System Operation:

1. Full Shutdown Mode:

a. Supply fan off.
b. Exhaust fan off.
c. Outside air damper shut.
d. Exhaust air damper shut.
e. Heating coil hydronic control valve modulating to maintain 55 degrees F minimum discharge air temperature.
f. Cooling coil hydronic three-way control valves shut (no flow through coil).

2. Start Sequence:

a. Provide independent, adjustable, automatic start/stop sequence for AHU-4 system based on time-of-day schedule.
b. Provide a minimum 5-second time delay between the start of AHU supply fan and exhaust fan.
c. AHU-4 to operate at a significantly reduced airflow in Unoccupied Mode in order to maintain negative pressure relationships in specific zones.

3. Supply Fan Speed Control:

a. Locate duct static pressure sensor in main supply air duct, approximately 3/4 the distance between the AHU supply outlet and most remote zone variable air volume (VAV) terminal unit branch duct connection. Suggested location is shown on the drawings.
b. Utilizing the fan variable speed drive (VSD) controller, modulate supply fan speed to maintain duct static pressure at 1.5 inches WC setpoint pressure.
c. Program AHU to go into Full Shutdown Mode in the event of VSD failure. Require manual restart of the system.

4. Exhaust Fan Speed Control:

a. Locate duct static pressure sensor in main exhaust air duct, approximately 3/4 the distance between the AHU exhaust inlet and most remote zone exhaust air valve (EAV) terminal unit branch duct connection. Suggested location is shown on the drawings.
b. Utilizing the fan variable speed drive (VSD) controller, modulate exhaust fan speed to maintain exhaust duct static pressure at -1.5 inches WC setpoint pressure.
c. Program AHU to go into Full Shutdown Mode in the event of VSD failure. Require manual restart of the system.

5. Supply Temperature Control:

a. Pre-Occupancy Warm-Up/Cool-Down Mode:
   1). Initial Conditions: The ventilating system is in Full Shutdown Mode.
   2). Initiate pre-occupancy warm-up/cool-down cycle one hour prior to scheduled Occupied Mode operation.
   3). Start AHU using start sequence.
   4). Control fan speeds using fan speed control sequence.
   5). Operate heat recovery system per heat recovery system control sequence.
   6). Warm-Up: Modulate heating coil hydronic control valve to maintain 55 degrees F supply air setpoint temperature as measured downstream of supply fan.

7). Mechanical Cool-Down: If outdoor air temperature is greater than 65 degrees F, modulate open hydronic cooling control valve to maintain supply air setpoint temperature.

b. Occupied Mode:
1). System has completed Pre-Occupancy Warm-Up/Cool-Down Mode and zones are at Occupied Mode temperature setpoints.
2). Measure supply air temperature downstream of heat recovery coil using duct averaging flexible sensors. If supply air temperature is less than 55 degrees F setpoint shift to Heating Mode. Modulate heating coil hydronic control valve to maintain 55 degrees F supply air setpoint temperature measured downstream of supply fan.
3). If supply air temperature downstream of the heat recovery coil is greater than 55 degrees F setpoint, the heating coil hydronic control valve has been shut for three minutes, and the heat recovery system has been disabled for three minutes, shift to Cooling Mode. Modulate cooling coil hydronic control valve to maintain supply air temperature setpoint.

c. Unoccupied Mode:
1). AHU is initially operating in Occupied Mode.
2). Shift ventilation system to Unoccupied Mode.
3). The hydronic heating system operates to maintain 65 degrees F night setback temperature setpoint plus 3, minus 0 degrees F using perimeter heat only.
4). If any zone falls below setback temperature setpoint, operate the applicable ventilating system using Pre-Occupancy Warm-Up Mode sequences.
5). Provide 15-minute minimum supply fan run time and 5-minute minimum system off time.
6). If any thermostat occupancy override button is pushed, operate the ventilation system in Occupied Mode for a two hour period.

C. Heat Recovery System: See Article 3.16 Heat Recovery System.

D. Typical Zone VAV Temperature Control with Reheat and Exhaust Air Valve (EAV):

1. Zone Sensors: Provide wall-mounted zone thermostat with input to zone VAV terminal equipment controller:

2. Occupied Mode Operation:

a. Heating Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Modulate VAV reheat coil control valve in parallel with control damper. Modulate the EAV between minimum CFM and maximum CFM to maintain the zone supply and exhaust offset as determined during testing, adjusting and balancing.
b. Cooling Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Cooling CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Reheat coil control valves remain shut. Modulate the EAV between minimum CFM and maximum CFM to maintain the zone supply and exhaust offset as determined during testing, adjusting and balancing.

3. Unoccupied Mode Operation:

    a. Heating Mode: When AHU is operating, modulate VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone night setpoint temperature plus 0, minus 3 degrees F. Modulate VAV reheat coil control valve in parallel with control damper.
    b. Cooling Mode: Ventilation system remains off regardless of zone temperature.

E. Typical Zone VAV Temperature Control with Reheat and Auxiliary Heat (Radiant Panel) and EAV:

1. Zone Sensors: Provide wall-mounted zone thermostat with input to zone VAV terminal equipment controller.

2. Occupied Mode Operation:

    a. Heating Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Modulate reheat coil and auxiliary heat control valves in parallel with control damper. Modulate the EAV between minimum CFM and maximum CFM to maintain the zone supply and exhaust offset as determined during testing, adjusting and balancing.
    b. Cooling Mode: Modulate the VAV terminal unit control damper between Minimum CFM and Maximum Cooling CFM to maintain zone day setpoint temperature plus or minus 1-degree F. Reheat coil and auxiliary heat control valves remain shut. Modulate the EAV between minimum CFM and maximum CFM to maintain the zone supply and exhaust offset as determined during testing, adjusting and balancing.

3. Unoccupied Mode Operation:

    a. Heating Mode: When AHU is operating, modulate VAV terminal unit control damper between Minimum CFM and Maximum Heating CFM to maintain zone night setpoint temperature plus 0, minus 3 degrees F. Modulate VAV reheat coil and auxiliary heat control valves in parallel with control damper.
    b. Cooling Mode: Ventilation system remains off regardless of zone temperature.

F. Safety Shutdowns:

1. General:

    a. “Hardwire” system safety shutdowns to provide safe, reliable operation in the event of Building Automation System (BAS) failure.
    b. Where equipment is provided with packaged stand-alone controls, capable of operating the equipment independently from the BAS, provide control logic which shifts the equipment to stand-alone operation in the event of BAS failure.

2. Fire Alarm Shutdown:

    a. Monitor fire alarm panel “General Alarm” status from BAS system.
    b. On “General Alarm” from fire alarm panel, the BAS shall:

1). Verify supply and exhaust fans are off. If fans are operating, stop supply and exhaust fans.
2). Shut outside air damper.
3). Shut exhaust damper.

3. High Duct Static Pressure Shutdown.

a. If ventilating system duct supply static pressure increases to 3.0 inches WC:
1). Command AHU-4 system to Full Shutdown Mode.
2). Provide "AHU-4 High Static Pressure" alarm.
3). Require manual restart of the ventilation system through the BAS.

4. Low Temperature Shutdown:

a. If supply air temperature decreases to 45 degrees F:
1). Command AHU-4 system in Full Shutdown Mode.
2). Provide "AHU-4 Low Temperature Shutdown" alarm.
3). Require manual restart of the ventilation system through the BAS.

G. Maintenance and Alarm Monitoring:

1. Air filter replacement monitoring:

a. Provide analog differential pressure sensor at each pre-filter bank:
1). Normal filter (MERV-8) differential pressure range is 0.27 inches WC (clean) to 0.90 inches WC (dirty) at 500 feet per minute.
2). Generate "AHU-X High Filter Differential Pressure" maintenance alarm at 0.80 inches WC.

b. Provide analog differential pressure sensor at each final filter bank:
1). Final filter (MERV-14) differential pressure range is 0.32 inches WC (clean) to 1.00 inches WC (dirty).
2). Generate "AHU-X High Filter Differential Pressure" maintenance alarm at 0.90 inches WC.

2. Zone Temperature Monitoring:

a. Generate "AHU-4 Zone Temperature High/Low" maintenance alarm if any zone temperature is not being maintained within setpoint band tolerance as described in Occupied Mode and Unoccupied Mode sequences.
b. During optimized start period, generate "AHU-X Zone Temperature High/Low" maintenance alarm if any zone temperature fails to meet occupied temperature setpoint.
c. Generate "AHU-4 Zone Low Temperature" critical alarm if any zone temperature falls below 55 degrees F.

3. Duct Static Pressure Monitoring:

a. Generate "Duct Static Pressure High/Low" maintenance alarm if duct pressure falls outside setpoint tolerance, plus or minus 0.05 inches WC.
b. Provide three-minute alarm time delay to prevent spurious alarms.

4. AHU Flow Monitoring:

    a. Provide BAS monitoring of variable speed drive enable/disable contacts, analog speed controller, and trouble contacts.
    b. Generate “VSD Fault” alarm if the VSD fan motor controller goes into fault.

3.5 GENERAL EXHAUST FAN OPERATION (EF-1 THRU 3)

A. Each exhaust fan unoccupied/occupied mode shall be set to match its associated air handling unit (AHU) mode.

B. Unoccupied Mode:

1. Exhaust fan is disabled.

2. Two-position motor operated damper with end-switch is closed.

C. Occupied Mode:

1. Two-position motor operated damper with end-switch opens.

2. Once damper is fully open, exhaust fan is enabled.

D. Monitoring and Alarms:

1. Monitor exhaust fan motors and generate a fan specific “EF-X Trouble” alarm when any exhaust fan fails to start during Occupied Mode operation.

2. Monitor motor operated dampers and generate a fan specific “EF-X Motor Operated Damper Trouble” alarm if damper fails to open/close when commanded.

3.6 MORGUE EXHAUST FAN OPERATION (EF-4)

A. Exhaust fan is scheduled to operate 24/7.

B. Full shutdown mode:

1. Exhaust fan is disabled.

2. Two-position motor operated damper with end-switch is closed.

C. Enabled mode:

1. Two-position motor operated damper with end-switch opens.

2. Once damper is fully open, exhaust fan is enabled.

D. Monitoring and Alarms:

1. Monitor exhaust fan motor and generate “EF-4 Trouble” alarm if the exhaust fan fails to start when enabled.

2. Monitor motor operated damper and generate “EF-4 Motor Operated Damper Trouble” alarm if damper fails to open/close when commanded.

3.7 EXAM ISOLATION (124) EXHAUST FAN OPERATION (EF-5)

A. Exhaust fan is scheduled to operate 24/7.

B. Full shutdown mode:

1. Exhaust fan is disabled.

2. Two-position motor operated damper with end-switch is closed.

C. Enabled mode:

1. Two-position motor operated damper with end-switch opens.

2. Once damper is fully open, exhaust fan is enabled.

D. Room Pressure Monitoring:

1. Provide room pressure monitor for the Airborne Infection Isolation (AII) room named Exam Isolation (124); locate static pressure reference heads, differential pressure transmitter, and wall-mount digital display as shown on the drawings.

2. Coordinate with testing, adjusting, and balancing contractor to provide supply and exhaust airflow offset to maintain a room differential setpoint of -0.05 inches WC.

3. If room differential pressure setpoint drops below -0.01 inches WC for more than 30 seconds, generate “Isolation Room Low Pressure” alarm on the BAS and on the local wall-mount digital display.

4. Provide door contacts for door into Isolation Room. Indicate door open/closed status on BAS graphics. Disable pressure alarm if door is in the open position. Generate local alarm if door is held open for more than 90 seconds.

E. Additional Monitoring and Alarms:

1. Monitor exhaust fan motor and generate “EF-5 Trouble” alarm if the exhaust fan fails to start when enabled.

2. Monitor motor operated damper and generate “EF-5 Motor Operated Damper Trouble” alarm if damper fails to open/close when commanded.

3.8 GARAGE VENTILATION (EF-6)

A. The garage is provided with minimum required ventilation through outside air make-up for the morgue exhaust. The garage exhaust fan (EF-6) is enabled and provides required ventilation to "purge" the garage when concentrations of carbon monoxide (CO) or nitrogen dioxide (NO2) get too high. Make-up air for the exhaust fan is provided by a make-up air louver.

B. Disabled mode:

1. Exhaust fan is disabled.

2. Exhaust fan and make-up air louver two-position motor operated dampers with end-switches are closed.

C. Purge mode:

1. High CO or NO2 levels are sensed by the gas detection sensors for more than 30 seconds.

2. Exhaust fan and make-up air louver two-position motor operated dampers with end-switches are opened.

3. Once dampers are fully open, exhaust fan is enabled.

4. Once CO or NO2 levels return to normal levels for more than one minute, garage ventilation system goes into disabled mode.

5. Exhaust fan minimum run time of 10 minutes.

D. Monitoring and Alarms:

1. Monitor gas detection sensors and provide "Garage High Gas Concentration" alarm if either gas has high concentration.

2. Monitor exhaust fan motor and generate "EF-6 Trouble" alarm if the exhaust fan fails to start when enabled.

3. Monitor fan motor operated damper and generate "EF-6 Motor Operated Damper Trouble" alarm if damper fails to open/close when commanded.

4. Monitor make-up air motor operated dampers and generate "Make-up Air Motor Operated Damper Trouble" alarm if damper fails to open/close when commanded.

3.9 DRYER BOOSTER FAN (EF-7)

A. Dryer booster fan utilizes packaged pressure controls to enable and modulate fan speed to maintain the desired exhaust pressure setpoint to provide the required exhaust airflow when the dryer is operational.

B. No monitoring provided by BAS.

3.10 MECHANICAL ROOM VENTILATION SYSTEM (SCF-1)

A. Description:

1. Mechanical room ventilation system SCF-1 provides ventilation cooling for the boiler room whenever heat gain from the boilers exceeds room heat loss and combustion air heating requirements.

2. The fan includes an outside air intake louver, mixing box, small cabinet fan with medium efficiency filter section, and discharge air temperature sensor.

3. A direct combustion air wall opening with associated louver and insulated duct elbow provides combustion air to fuel oil fired equipment when SCF-1 is not operating.

4. Excess air from the SCF-1 ventilation system is relieved through the combustion air intake louver when SCF-1 is operating.

B. Zone Thermostat: Provide wall mounted thermostat with output signal to BAS system.

C. Cooling Mode:

1. Start fan SCF-1 when mechanical room temperature increases above 75 degrees F setpoint temperature.

2. Modulate mechanically linked mixing box outside air and return air dampers to maintain 55 degrees F supply air discharge temperature.

3. When mechanical room temperature falls to 70 degrees F, stop SCF-1. Shut outside air damper and fully open return air damper.

D. Low temperature shutdown.

1. Stop fan, close outside air damper and fully open return air damper if discharge supply temperature is less than 45 degrees F.

2. Provide “SCF-1 Low Temperature” alarm to BAS.

3. Allow system to automatically restart via the BAS after minimum system off time.

E. Minimum Run Timer: Provide 10-minute minimum system run time and 5-minute minimum system off time.

F. Filter Monitoring:

1. Provide analog differential pressure sensor across filter bank. Normal filter (MERV-8) differential pressure range is 0.28 inches WC (clean) to 0.90 inches WC (dirty) at 500 feet per minute.

2. Generate “SCF-1 High Filter Differential Pressure” alarm at 0.80 inches WC.

G. Fan Monitoring: Monitor supply fan motor and generate “SCF-1 Trouble” alarm if fan fails to start when it has been enabled.

3.11 TELECOMMUNICATIONS ROOM (232) AIR-CONDITIONING SYSTEM (AC-1)

A. General System Description: The Telecommunications Room air-conditioning system consists of an evaporator unit located within the Telecommunications Room and a condensing unit located in the Garage for waste heat recovery. The dedicated air-conditioning system has packaged controls to maintain zone temperature.

B. Operate dedicated air conditioning system utilizing packaged microprocessor control system. Monitor general fault alarm through BAS.

3.12 HYDRONIC HEATING SYSTEM OPERATION

A. General System Description:

1. The hydronic heating system consists of two identical cast iron hydronic boilers (BLR-1 and BLR-2) each sized for approximately 60 percent of the building's design heating load. The boilers are arranged in a primary/secondary piping arrangement. Each boiler has a dedicated primary loop circulator (PMP-1, PMP-2).

2. One set of secondary heating loop variable speed pumps (PMP-3A and PMP-3B), arranged in parallel, and each sized for 100 percent system zone flow provide circulation to AHU coils, VAV boxes, perimeter fintube, radiant panels, cabinet unit heaters and unit heaters throughout the facility.

3. AHU-1, 2, and 3 heating coils have primary/standby pumps (PMP-7A/-7B, PMP-8A/-8B, PMP-9A/-9B) to continuously circulate the heating coils during heating mode in order to provide uniform heat distribution over the entire coil and help prevent freezing the coil during cold outside air conditions.

B. Coordination with Packaged Boiler Controls:

1. Coordinate connection of the BAS to the packaged burner controllers.

2. Provide boiler enable/disable and sequencing, circulator pump operation and secondary loop temperature reset utilizing the BAS.

C. Full Shutdown Mode (Initial conditions):

1. Boilers off.

2. Boiler circulator pumps off.

3. Secondary heating loop circulator pumps off.

4. AHU heating coil recirculation pumps off.

D. Operating Mode:

1. System Enable:

a. Manual Mode: Provide three-position on/off/auto switch located on each burner control cabinet to allow local manual enable, disable or automatic burner control from the BAS (normal condition).

2. Lead/Lag Control:

a. Provide lead/lag control for boilers (BLR-1 and BLR-2). Alternate lead boiler monthly during the heating season.
b. Provide lead/lag control for secondary loop circulators (PMP-3A and PMP-3B). Alternate lead loop pump monthly during the heating season.

3. System Start-up:

a. Start lead secondary loop circulator pump. Operate secondary circulator pumps with lead pump in "run" and standby pump in "standby." If lead pump fails to start as determined by analog current sensor, disable lead pump and start standby pump.
b. After secondary loop flow has been established for 10 minutes, enable boiler operation.

4. Boiler Operation:

a. Calculate "secondary loop water temperature setpoint" in accordance with the following linear reset schedule:

Hydronic System Temperature Reset Schedule	
Outside Air Temperature	Secondary Loop Water Temperature Setpoint
60 Degrees F	160 Degrees F
0 Degrees F	190 Degrees F

b. Compare actual secondary loop temperature (sensor located upstream of air separator AS-1) with computed secondary loop water temperature as determined by reset schedule.
c. If actual water temperature is lower than water temperature required by reset schedule:
   1). Start lead boiler circulator pump.
   2). Command lead boiler to "Low Fire" mode from the BAS system utilizing packaged burner control start-up sequence.

d. Track the actual secondary loop water temperature rate-of-rise. If one time constant elapses and rate-of-rise is insufficient to achieve "computed water temperature setpoint," modulate burner to achieve the "computed water temperature setpoint."
e. If lead boiler is modulated to "High Fire" and rate-of-rise is still insufficient to achieve "computed water temperature":
   1). Start lag boiler circulator pump.
   2). Command lag boiler to "Low Fire" mode from the BAS system utilizing packaged burner control start-up sequence.

f. Continue boiler sequence until secondary loop temperature setpoint is reached or both boilers are operating in "High Fire" mode.
g. Reverse sequence if actual secondary loop water temperature is greater than computed secondary loop water temperature setpoint.
h. Boilers must modulate to "Low Fire" mode prior to full shutdown. After a boiler is commanded to shut down, operate associated circulator pump for 5 minutes utilizing a time delay relay.
i. Coordinate with boiler manufacturer's representative and adjust setpoints and time constants in accordance with manufacturer's recommendations.

5. System Shutdown:

a. Initiate Full Shutdown Mode in the following events:
1). Manual "off" mode.
2). Low water cutoff shutdown of either boiler.

E. Variable Speed Hydronic Pump Control (PMP-3A and PMP-3B):

1. Provide a separate hydronic system pressure sensor in each main hydronic header branch line (see plans for approximately locations). Locate each sensor approximately 3/4 the distance between the secondary loop circulator pump combined discharge and the most remote terminal heating unit control valve in each branch.

2. Adjust VSD controller output to modulate pump speed between 35 percent and 100 percent flow to maintain the lowest reading hydronic header pressure sensor at setpoint pressure with a minimum of one terminal heating unit control valve at 95 percent open. Set initial header pressure setpoint to 5 PSIG. Setpoint to be adjusted during testing, adjusting and balancing.

3. In the event of VSD failure, enable and run standby pump.

F. AHU Heating Coil Recirculation Pumps (PMP-7A/-7B, PMP-8A/-8B, PMP-9A/-9B) Control:

1. When outside air temperature is 35 degrees F and decreasing, and associated AHU heating coil control valve opens greater than 0 percent, start applicable heating coil circulator pump:

a. Start lead circulator pump. Operate circulator pumps with lead pump in "run" and standby pump in "standby."
b. If lead pump fails to start as determined by analog current sensor, disable lead pump and start standby pump.

2. See ventilation system sequences for additional requirements.

G. Hydronic System Monitoring and Alarm:

1. Boiler safeguard alarms (BLR-1 and BLR-2):

a. Generate a separate "BLR-X Flame Failure" alarm if either boiler is shut down by its flame safeguard control system.

b. Generate a “Low Water System Shutdown” alarm upon a low water condition as sensed by the low water cut-off.

2. Boiler circulator pump (PMP-1 and PMP-2) trouble alarms:

a. Provide current sensing (analog) for each pump.
b. Disable applicable flame safeguard circuit and generate a “PMP-X Trouble” alarm if either pump fails to run when its respective boiler is enabled.

3. Secondary loop pump trouble alarms (PMP-3A and PMP-3B):

a. Provide current sensing (analog) for each pump.
b. Generate “Secondary Loop Pump Failure” alarm if lead pump fails to run when enabled by the BAS.
c. Generate “Secondary Loop Pump Critical Failure” alarm if standby pump fails to run when enabled by the BAS after a lead pump failure.
d. Generate “Secondary Loop Pump Trouble” alarm if both pumps are running.

4. AHU heating coil circulation pump trouble alarms (PMP-7A/-7B, PMP-8A/-8B, PMP-9A/-9B):

a. Provide current sensing (analog) for each pump.
b. Generate a separate “PMP-X Trouble” alarm if any pump fails to operate when outside air temperature is below setpoint.

5. Hydronic System Low Pressure Alarms:

a. Monitor the heating system pressure with an analog pressure sensor.
b. Generate a “Hydronic Heating System Low Pressure” alarm if the system pressure falls below 5 PSIG.

3.13 RADIANT SLAB HEATING

A. Description:

1. The saunas utilize a radiant floor hydronic heating system to maintain zone temperature control when the saunas are not in operation.

2. The radiant floor heating system operates to maintain a constant floor setpoint temperature utilizing slab floor temperature sensors. Floor temperature is reset based on outside air temperature.

B. System Shutdown:

1. Zone circulator pump is off.

2. Zone three-way valve is open (full recirculation of radiant floor loops).

C. Typical System Operation:

1. When outside air temperature decreases to 60 degrees F start zone circulator pump.

2. Operate circulator pump for one hour to allow slab temperature to stabilize.

3. After slab temperature stabilization period, measure floor slab temperature. Modulate three-way valve to maintain scheduled floor slab temperature based on outside air temperature as follows:

Floor Slab Temperature Reset Schedule	
Outside Air Temperature	Slab Floor Temperature Setpoint
Greater than 60 Degrees F	System off
60 Degrees F	65 Degrees F
0 Degrees F or less.	85 Degrees F

4. Control three-way valve to limit maximum supply water temperature to 120 degrees F, as measured by supply water temperature sensor located downstream of zone circulator.

5. When outside air temperature increases to 65 degrees F and increasing, stop zone circulator and open three-way valve (full recirculation of radiant floor loops).

D. Radiant Floor Heating System Monitoring and Alarm:

1. Zone circulator pump trouble alarms:

a. Provide current sensing (analog) for pump.
b. Generate “PMP-6 Failure” alarm if pump fails to operate when command to start from the BAS.

2. High Temperature Alarms:

a. If zone supply temperature water exceeds 130 degrees F, generate a “Radiant Floor High Supply Water Temperature” alarm.
b. If any slab temperature sensor exceeds 90 degrees F, generate a “Radiant Floor High Floor Temperature” alarm.

3.14 HYDRONIC HEATING SYSTEM DEVICES

A. AHU Heating Coils (AHU-1 through AHU-4): See ventilation system control sequences.

B. Zone VAV Terminal Reheat Coils (AHU-1 through AHU-4): See ventilation system control sequences.

C. Finned Tube Radiators: See ventilation system control sequences.

D. Radiant Ceiling Panels:

1. Radiant ceiling panel included with zone VAV terminal unit control: See ventilation system control sequences.

2. Stand-alone radiant panel:

   a. Occupied Mode: Modulate radiant ceiling panel control valve to maintain the zone occupied space temperature setpoint plus or minus 1-degree F.
   b. Unoccupied Mode: Modulate radiant ceiling panel control valve to maintain the zone unoccupied space temperature setpoint plus or minus 1-degree F.

E. Cabinet Unit Heaters:

1. At 65 degrees F and decreasing, start recirculating fan and open hydronic control valve.

2. At 68 degrees F and increasing, stop recirculating fan and shut hydronic control valve.

F. Hydronic Unit Heaters:

1. At 65 degrees F and decreasing, start recirculating fan and open hydronic control valve.

2. At 68 degrees F and increasing, stop recirculating fan and shut hydronic control valve.

3.15 HYDRONIC COOLING SYSTEM OPERATION

A. Description:

1. The hydronic cooling system consists of a chiller (CH-1) sized for 100 percent of the building's design cooling load. The cooling distribution system is arranged in a primary only piping arrangement.

2. One set of constant speed circulation pumps (PMP-4A and PMP-4B), arranged in parallel and each sized for 100 percent system zone flow, provide circulation to AHU cooling coils. AHU cooling coils have three-way valves to modulate fluid flow through the coil in order to maintain the supply air temperature setpoint.

3. The hydronic cooling system utilizes a 40 percent propylene glycol/water mixture to transfer heat. A packaged glycol make-up tank (GM-1) maintains system pressure and automatically makes up any fluid lost.

B. Full Shutdown Mode (Initial conditions):

1. Chiller (CH-1) is disabled.

2. Circulation pumps (PMP-4A and PMP-4B) are disabled.

C. Operating Mode:

1. System Start-up:

   a. When one AHU calls for mechanical cooling by modulating its cooling coil three-way valve partially open (flow to coil), enable cooling system circulation pump.

b. Allow pump to operate for 3 minutes to equalize system temperature.
c. After three minutes, enable chiller to operate to maintain cooling system supply temperature setpoint.

2. Lead/Lag Control:

a. Provide lead/lag control for cooling loop pumps.
b. Alternate lead loop pump monthly during the cooling season.

3. Chiller Operation: The chiller utilizes packaged controls to maintain the chilled glycol supply temperature setpoint of 44 degrees F.

4. Coil Operation: See ventilation system control sequences.

D. Hydronic System Monitoring and Alarm:

1. Chiller alarm:

a. Monitor chiller dry contact.
b. Generate “Chiller Trouble” general alarm if the chiller goes into an alarm condition.

2. Circulation pump trouble alarms:

a. Provide current sensing (analog) for each pump.
b. Generate “Cooling Loop Pump Failure” alarm if lead pump fails to run when enabled by the BAS.
c. Generate “Cooling Loop Pump Critical Failure” alarm if standby pump fails to run when enabled by the BAS after a lead pump failure.
d. Generate “Cooling Loop Pump Trouble” alarm if both pumps are running.

3. Hydronic Cooling System High Temperature Alarm:

a. Monitor the glycol supply temperature with an analog temperature sensor.
b. Generate a “Hydronic Cooling System High Temperature” alarm if the system temperature increases 3 degrees F above the setpoint temperature for more than 60 seconds.

4. Hydronic Cooling System Low Pressure Alarm:

a. Monitor the cooling loop system pressure with an analog pressure sensor.
b. Generate a “Hydronic Cooling System Low Pressure” alarm if the system pressure falls below 10 PSIG.

3.16 HEAT RECOVERY SYSTEM

A. General System Description:

1. A runaround coil loop energy recovery system removes energy from the dental area’s exhaust air stream (heat recovery coil RC-4B). This energy is used to preheat AHU-4 incoming outdoor air (heat recovery coil RC-4A). In addition, heat exchanger HX-1 can

add energy into the runaround loop to provide additional preheat capability when the heat recovery alone is insufficient, and to provide freeze protection.

2. Primary/standby pumps (PMP-5A and PMP-5B) circulate fluid through the loop, varying speed to match load conditions. Fluid makeup and pressure control is provided by glycol makeup unit GM-2 and expansion tank ET-3. Fluid is 40 percent ethylene glycol / 60 percent water.

B. Pump speed control (PMP-5A and PMP-5B):

1. Provide lead/lag control for heat recovery loop circulators. Alternate lead loop pump monthly during the heating season.

2. Start lead heat recovery circulator pump at full speed whenever AHU-4 supply and exhaust fans are operating.

3. Operate circulator pumps with lead pump in "run" and standby pump in "standby." In the event of VSD failure, enable and run standby pump.

4. Run pump at full speed except during conditions described below.

5. During warmer weather, modulate pump speed to maintain RC-4A leaving air temperature (LAT) of 55 degrees F. Stop pump if pump is at minimum speed and LAT rises above setpoint.

C. Preheat temperature and frost protection control (HX-1):

1. Modulate hydronic heating 3-way control valve for HX-1 to maintain minimum RC-4B coil entering fluid temperature (EFT) of 30 degrees F to avoid frost buildup on the coil. The intent is to maximize recovery potential by keeping EFT as low as possible without frosting coil.

2. Provide operator override ability to change control of HX-1 to meet RC-4A LAT setpoint listed above. This will have the effect of reducing the amount of heat recovery and increasing the HX-1 load, but will provide additional heating capacity if needed.

D. Monitoring and Alarms:

1. Monitor the following points:

a. Coil RC-4A Entering Air Temperature (EAT) and LAT. NOTE: Coil RC-4A EAT is the outdoor air temperature and may be mapped in from the outdoor air temperature sensor.
b. Coil RC-4B EAT, LAT, and EFT.

2. Heat recovery system pump trouble alarms (PMP-5A and PMP-5B):

a. Provide current sensing (analog) for each pump.
b. Generate "Heat Recovery System Pump Failure" alarm if lead pump fails to run when enabled by the BAS.

c. Generate “Heat Recovery System Pump Critical Failure” alarm if standby pump fails to run when enabled by the BAS after a lead pump failure.
d. Generate “Heat Recovery System Pump Trouble” alarm if both pumps are running.

3. Generate alarms for the following conditions:

a. Coil RC-4A:
1). LAT less than or equal to 34 degrees F.
2). Alarm message to read “Heat recovery coil RC-4A low air temperature, check operation of frost protection controls”.

b. Glycol makeup system (GM-2):
1). Provide low level alarm.
2). Alarm message to read “Check heat recovery system glycol tank level”.

c. Heat Recovery System Low Pressure Alarms:
1). Monitor system pressure with an analog pressure sensor.
2). Generate a “Heat Recovery System Low Pressure” alarm if the system pressure falls below 5 PSIG.

3.17 PLUMBING

A. Domestic Water Heater (WH-1A and WH-1B):

1. Utilize packaged water heater controls.

2. Set aquastat to 140 degrees F.

3. Monitoring and Alarms:

a. Provide fluid temperature sensors in discharge piping on both water heaters to monitor domestic hot water supply temperature.
b. If hot water supply temperature increases above 140 degrees F for a period of 5 minutes, provide “High Domestic Hot Water Temperature” alarm.
c. If hot water supply temperature decreases below 130 degrees F for a period of 5 minutes, provide “Low Domestic Hot Water Temperature” alarm.

B. Domestic Hot Water Circulation Pump (PMP-P1):

1. Provide hot water circulation temperature sensor in return piping located outside of the level 1 Mechanical Room.

2. If return water temperature decreases below 115 degrees F, enable circulation pump.

3. If return water temperature increases above 120 degrees F, disable circulation pump.

C. Elevator Sump Pump (PMP-P2).

1. The elevator sump pump operates automatically on high elevator sump water level utilizing a packaged float switch.

2. Provide BAS alarm monitoring point for the sump pump controller (utilizing controller relay connection).

3. Provide “Elevator Sump Pump High Water” alarm upon activation of high level float.

4. Provide “Elevator Oil Detection” alarm upon activation of sump pump oil sensing probe.

3.18 FUEL OIL

A. The fuel oil transfer system utilizes packaged controls to transfer fuel from the above ground storage tank (AST-1) to the interior day tank (DT-1) using a remote fuel oil transfer pump (RFP-1).

B. Monitoring and Alarms:

1. Provide “Underground fuel oil leak” alarm upon detection of fuel in either containment sump by leak detector sensors.

2. Provide BAS alarm monitoring point for the day tank controller. Provide “Day Tank Trouble” alarm upon activation of any day tank alarm.

END OF SECTION 259000