



City of Cambridge

PURCHASING DEPARTMENT

795 Massachusetts Ave. • Cambridge, Massachusetts 02139-3219

Amy L. Witts
Purchasing Agent

TO: All Bidders
FROM: City of Cambridge
DATE: June 16, 2014
RE: File No. 6435 – Solomons Transportation Center HVAC Replacement Project-
Addendum No. 2

The following additions and revisions have been made to the Electrical plans:

1. Revise Drawing E-0.2 ELECTRICAL RISERS, SCHEDULES AND DETAILS to add DF-1 to panel 'MP1' schedule.
2. Revise Drawing E2.0 ELECTRICAL NEW WORK PLANS to add circuit and disconnect for DF-1 on roof.

The following additions and revisions have been made to the HVAC plans:

3. Revise Drawing H-2.0 HVAC BASEMENT & FIRST FLOOR NEW WORK PLANS to increase boiler flue connection to common manifold and indicate lateral tee's at each connection.
4. Revise Drawing H2.1 HVAC MEZZANINE & ROOF NEW WORK PLANS to add draft control fan at new flue termination, to add draft fan schedule and to add draft control system operating sequence.

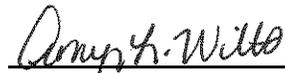
The following additions and revisions have been made to the HVAC specification:

5. 15500 Paragraph 2.18 AUTOMATIC TEMPERATURE CONTROLS, A. Manufacturers: - Replace "1. Automated Logic 2. Johnson Controls Company" with "1. Reliable Controls by Control Technology, Inc. 2. Automated Logic".
6. 15500 Paragraph 2.18 AUTOMATIC TEMPERATURE CONTROLS, B., 4. - Eliminate "The Automatic Temperature Control (ATC) Contractor shall be the same contractor as the HVAC Maintenance Contractor for this project; sub-contracting Automatic Temperature Control work will not be allowed."
7. 15500 Paragraph 1.10 SHOP DRAWINGS – Add "19. Draft Control Systems".
8. 15500 Add Paragraph 2.20 DRAFT CONTROL SYSTEMS –

- A. This system shall provide constant chimney pressures required by the heating appliance being vented. The following are components of the system:
1. US Draft Co., Termination Draft Control System, ETL-listed to UL STD378 & UL STD 705.
 2. Electrical connections, by installing contractor.
- B. Furnish US Draft Co. Termination draft inducer(s) with design volume and design pressure as scheduled on the drawings and specified. The draft inducer shall be listed to UL STD 378 and UL STD 705 and shall bear the listed mark from an OSHA approved NRTL.
1. The entire draft inducer shall be constructed of carbon steel and powder coated with a silicone based high temperature (1,000°F) coating. The draft inducer shall be constructed of minimum 16 ga. steel. The Draft inducer housing shall be continuously welded to insure liquid tight construction.
 2. The draft inducer impeller shall be statically and dynamically balanced with permanently attached balancing weights. Balancing weights shall be of the same material as the impeller.
 3. The draft inducer shall be listed for 575°F exhaust gas temperatures.
 4. The draft inducer motor shall be electronically commutated totally enclosed and outdoor rated. The motor shall have a minimum efficiency of 75%; permanent split capacitor motors shall not be approved.
- C. Performance
1. The draft inducer system shall be able to reach set-point within 15s of initial call for heat.
 2. The draft inducer system shall include an intelligent feed-back signal to determine the RPM of the motor.
 3. The draft inducer shall maintain the draft set-point to within +/- 0.01" W.C.
 4. The pressure control shall disable the appliances within the user determined time or 15s for oil appliances if the user determined pressure cannot be maintained.
- D. Sequence of operation
1. A call for heat is received by the pressure control which activates the sensor check function when available. Once the sensor functionality has been verified, the system controls the fan speed to achieve the set point. Once the set-point has been achieved, the system energizes the safety relay of the appliance calling for heat
 2. As individual appliances call for heat, the system will adjust the fan speed to maintain the set-point pressure. When all appliances have satisfied, the controller will disengage the draft inducer.
- E. Electrical requirements

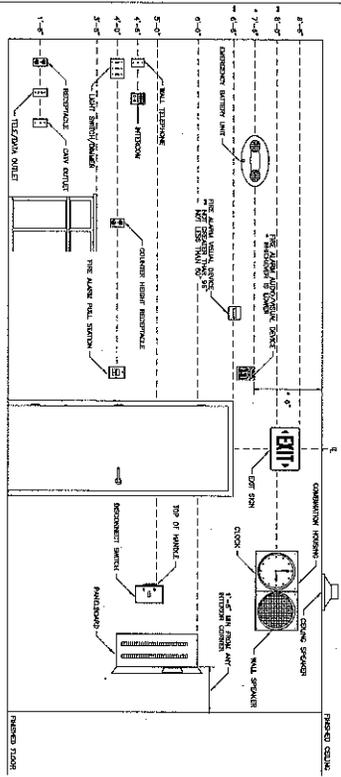
1. **Power supply shall be:**
 - a. **VIC series pressure control: 120VAC, single phase, 60Hz**
 - b. **EC motors: 120VAC or 240 VAC, single phase, 60Hz**
 - c. **VFD: 240VAC, single phase, 60Hz, 208VAC or 480VAC, three phase, 60Hz**
 - d. **Damper Actuator, 24 VDC, 1 amp.**
 2. **All wiring shall be in accordance with the National Electrical Code.**
 - a. **VIC series pressure controller**
 - b. **Draft Inducer**
 - c. **Supply Fan**
 - d. **Damper actuator**
 - e. **CGM-503 CO safety control**
- F. **All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 24 months from the date of delivery to the construction site. The warranty shall be provided by the equipment vendor and shall include the parts necessary to repair or replace all defective parts and materials.**
- G. **Installation and operation manuals shall be provided to the Owner's Representative, complete with product literature on the supply fan and controls, dimensional and wiring diagrams. Owner's Representative and designated personnel shall be instructed in the proper operation and maintenance of the packaged system.**

All other details remain the same.



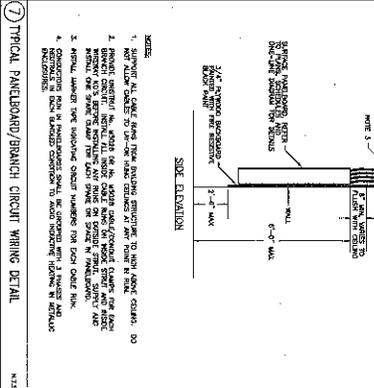
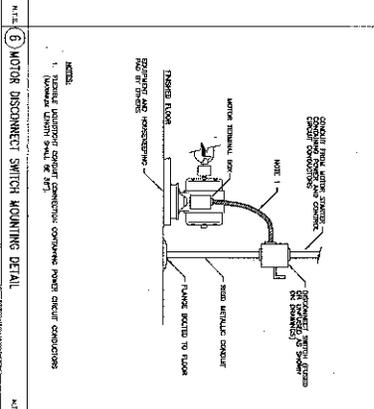
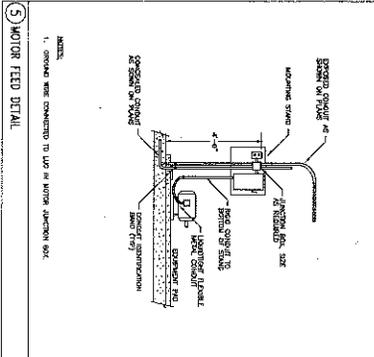
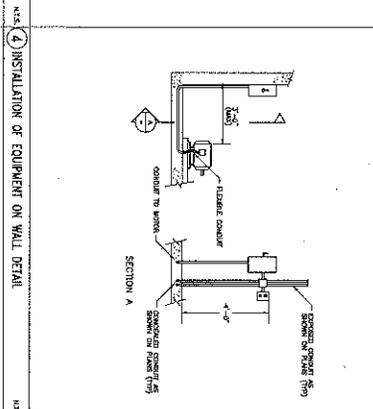
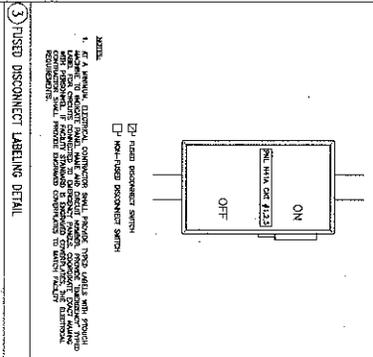
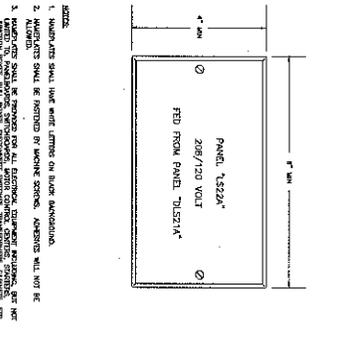
Amy L. Witts
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Addendum No. 2



1 DEVICE MOUNTING HEIGHT DETAIL

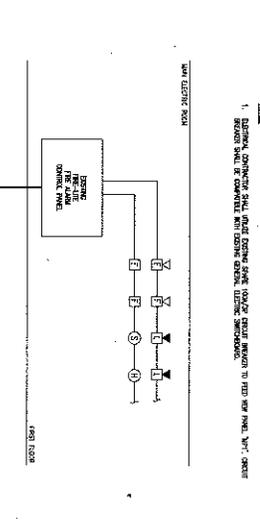
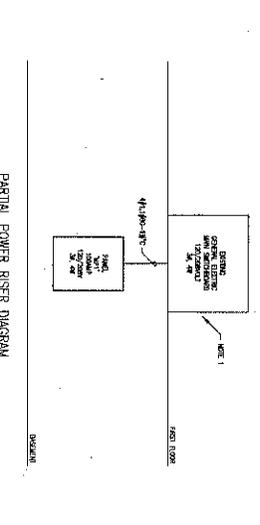
2 TYPICAL PANELMOUNT DETAIL



PANEL 1, 522A
208/120 VOLT

LOAD DISPOSITION

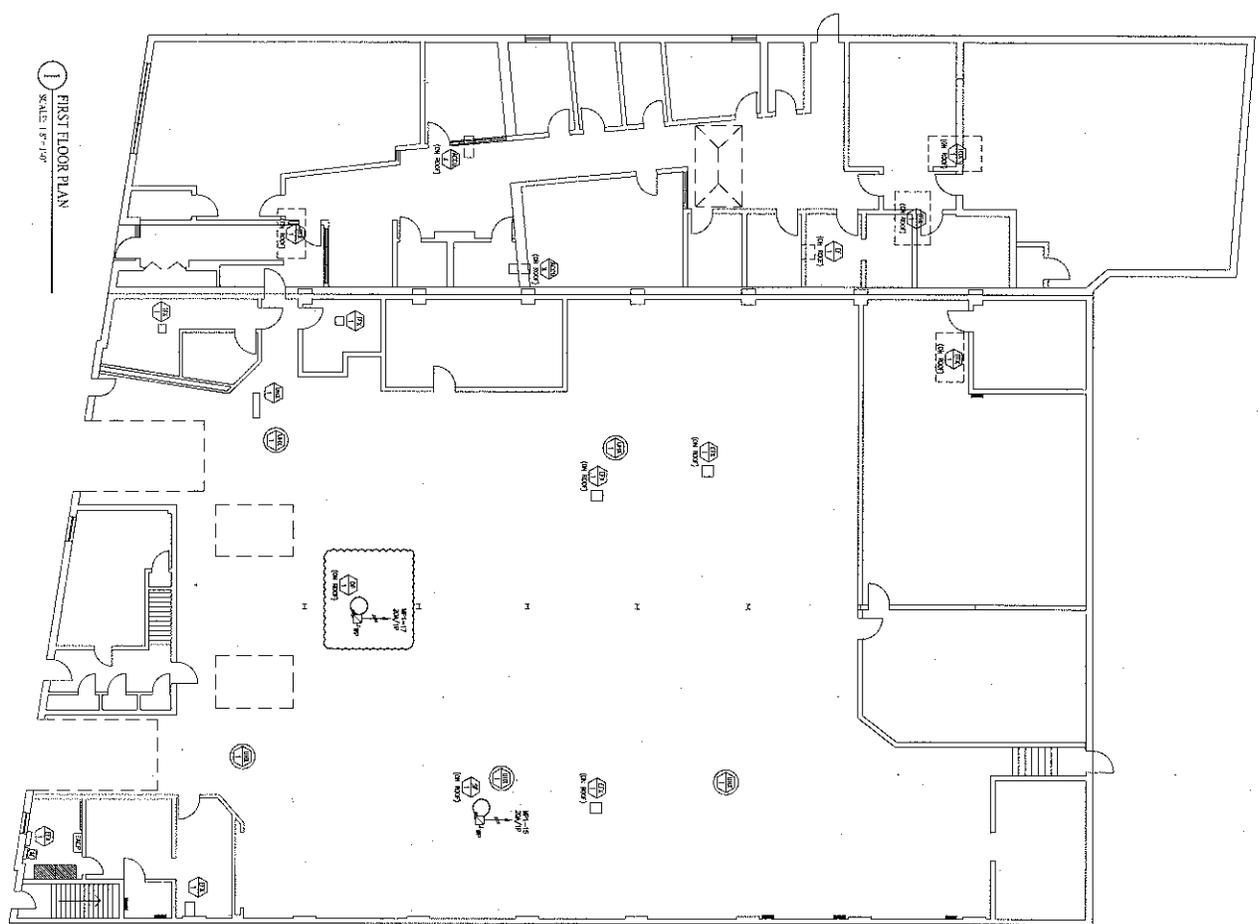
LOAD DISPOSITION	WATTAGE	VOLTS	AMPS	PHASE	WIRE SIZE	TERMINAL	LOAD DESCRIPTION
GENERAL ILLUMINATION	1000	120	8.3	A	14	1	GENERAL ILLUMINATION
RECEPTACLES	1000	120	8.3	B	14	2	RECEPTACLES
FIXTURES	1000	120	8.3	C	14	3	FIXTURES
CONTROLS	1000	120	8.3	D	14	4	CONTROLS
PHASE A	1000	120	8.3	A	14	5	PHASE A
PHASE B	1000	120	8.3	B	14	6	PHASE B
PHASE C	1000	120	8.3	C	14	7	PHASE C
PHASE D	1000	120	8.3	D	14	8	PHASE D
PHASE E	1000	120	8.3	A	14	9	PHASE E
PHASE F	1000	120	8.3	B	14	10	PHASE F
PHASE G	1000	120	8.3	C	14	11	PHASE G
PHASE H	1000	120	8.3	D	14	12	PHASE H
PHASE I	1000	120	8.3	A	14	13	PHASE I
PHASE J	1000	120	8.3	B	14	14	PHASE J
PHASE K	1000	120	8.3	C	14	15	PHASE K
PHASE L	1000	120	8.3	D	14	16	PHASE L
PHASE M	1000	120	8.3	A	14	17	PHASE M
PHASE N	1000	120	8.3	B	14	18	PHASE N
PHASE O	1000	120	8.3	C	14	19	PHASE O
PHASE P	1000	120	8.3	D	14	20	PHASE P
PHASE Q	1000	120	8.3	A	14	21	PHASE Q
PHASE R	1000	120	8.3	B	14	22	PHASE R
PHASE S	1000	120	8.3	C	14	23	PHASE S
PHASE T	1000	120	8.3	D	14	24	PHASE T
PHASE U	1000	120	8.3	A	14	25	PHASE U
PHASE V	1000	120	8.3	B	14	26	PHASE V
PHASE W	1000	120	8.3	C	14	27	PHASE W
PHASE X	1000	120	8.3	D	14	28	PHASE X
PHASE Y	1000	120	8.3	A	14	29	PHASE Y
PHASE Z	1000	120	8.3	B	14	30	PHASE Z



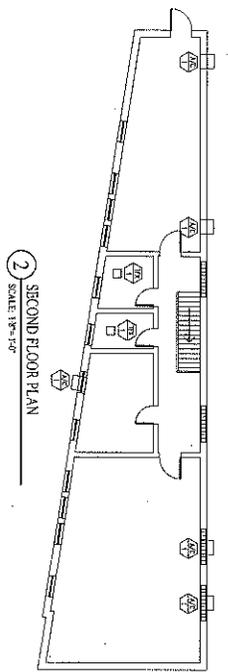
SOLOMON TRANS. CENTER
456 BROADWAY
CAMBRIDGE, MASSACHUSETTS
HVAC REPLACEMENT PROJECT
ELECTRICAL RISERS, SCHEDULES AND DETAILS

RUSSO BARR ASSOCIATES
70 Center Street 3rd Floor, Burlington, MA 01803

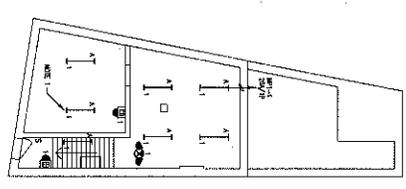
DATE: 05-09-14
SCALE: NONE
DRAWN BY: J. CHODUR
CHECKED BY: DSE/JCH
PROJECT NO: 2014023.00
DRAWING NO: E-02



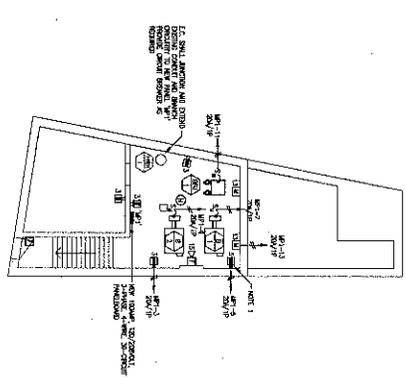
1 FIRST FLOOR PLAN
SCALE: 1/8"=1'-0"



2 SECOND FLOOR PLAN
SCALE: 1/8"=1'-0"



3 BASEMENT - LIGHTING PLAN
SCALE: 1/8"=1'-0"



4 BASEMENT - POWER AND FIRE ALARM PLAN
SCALE: 1/8"=1'-0"

NOTES:
1. ALL LIGHTING TO BE FINISHED, UNLESS NOTED OTHERWISE BY OWNER.

NOTES:
1. SHOW THE DISTANCE FROM SIGN PANEL COMPONENT EXACT LOCATIONS IN TITLE.

LIGHTING FIXTURE SCHEDULE

TRADE TYPE	DESCRIPTION	MANUFACTURER MODEL	LUMENS		VOLTAGE
			NO.	TYPE	
A	4' TUBESHADE (TYPE NOT SPECIFIED)	PHILIPS (TYPE NOT SPECIFIED)	1	20	120V/277V
B	EMERGENCY LIGHTS (TYPE NOT SPECIFIED)	PHILIPS (TYPE NOT SPECIFIED)	2	1.4	120
C	COMPACT FLUORESCENT LIGHTS (TYPE NOT SPECIFIED)	PHILIPS (TYPE NOT SPECIFIED)	2	1.4	120

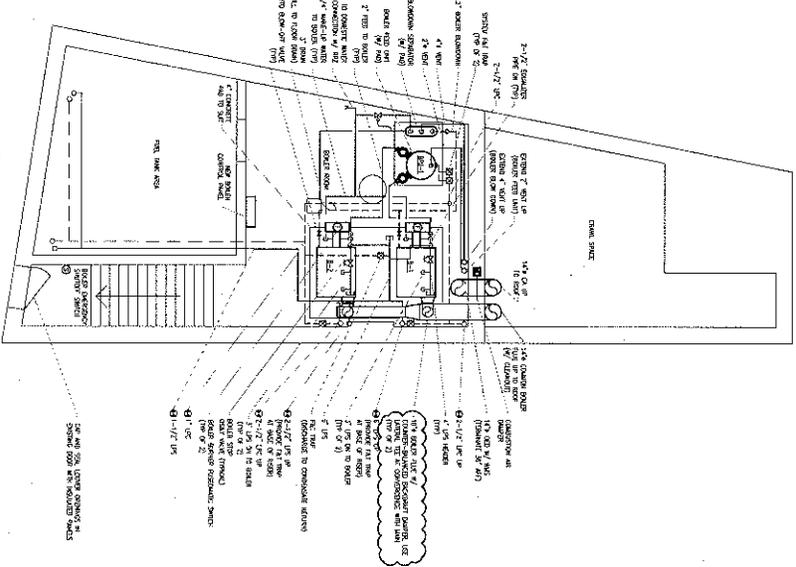
E-2.0
DATE: 05.08.14
SCALE: 1/8"=1'-0"
DRAWN BY: J. CHANDLER
CHECKED BY: DSK/JCB
PROJECT NO.: 2014023.00
DRAWING NO.

SOLOMON TRANS. CENTER
456 BROADWAY
CAMBRIDGE, MASSACHUSETTS
HVAC REPLACEMENT PROJECT
ELECTRICAL NEW WORK PLANS

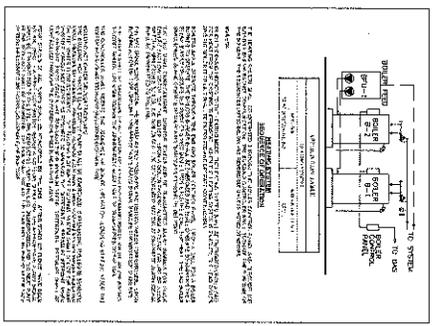
RUSSO-BARR
ASSOCIATES
32 Green Street 3rd Floor, Burlington, MA 01803

NO.	DATE	BY	DESCRIPTION

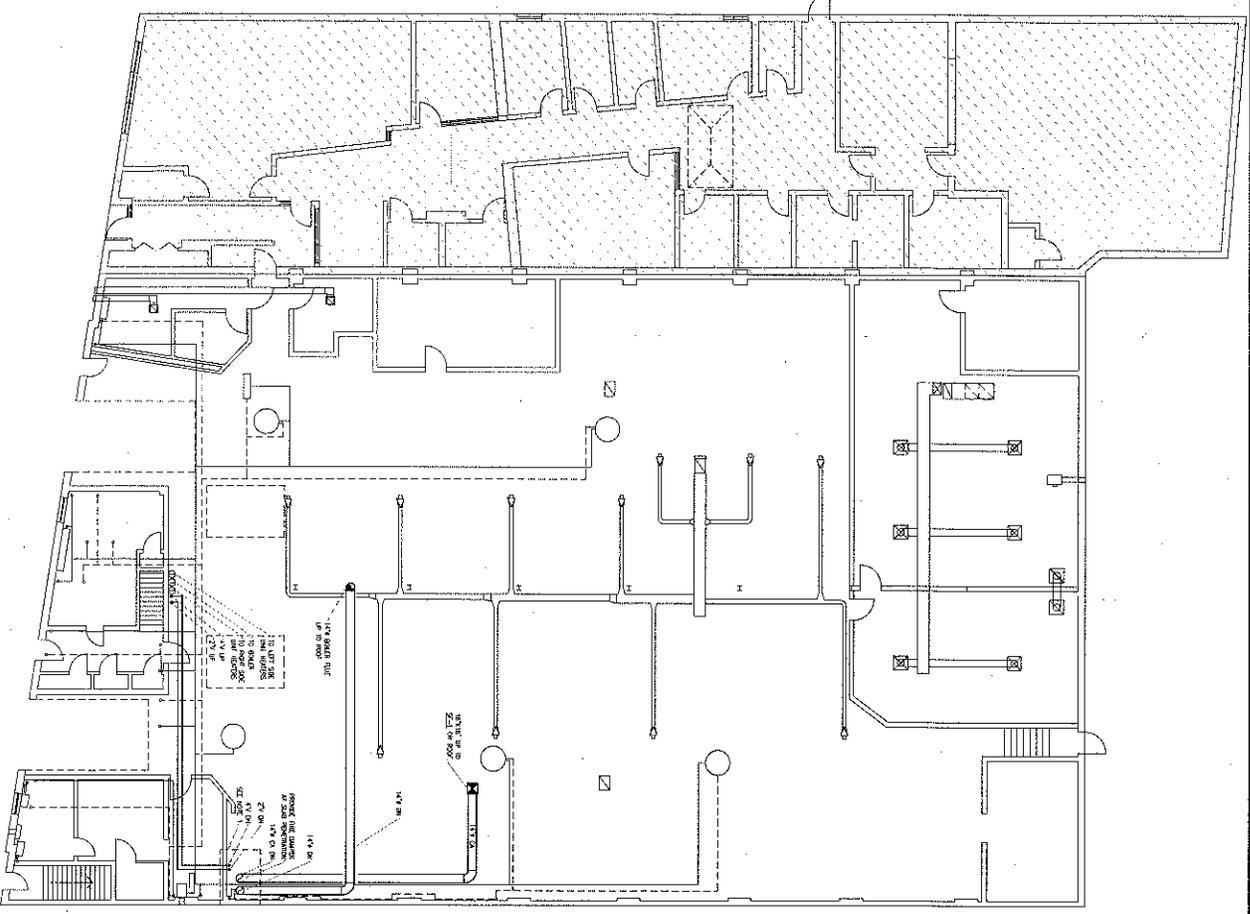
1 HVAC - Basement New Work Plan
SCALE: 1/8" = 1'-0"



- NOTES:**
- 1) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).
 - 2) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).
 - 3) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).
 - 4) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).
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 - 6) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).
 - 7) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).
 - 8) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).
 - 9) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).
 - 10) ALL WORK SHALL BE IN ACCORDANCE WITH THE 2018 MASSACHUSETTS MECHANICAL CODE (M.C.) AND THE 2018 MASSACHUSETTS GAS CODE (M.G.C.).



2 HVAC - First Floor New Work Plan
SCALE: 1/8" = 1'-0"



H-2.0

DATE: 05.09.14
SCALE: 1/8" = 1'-0"
DRAWN BY: JG/MMS
PROJECT NO: 2014023.00
DRAWING NO:

SOLOMON TRANS. CENTER
456 BROADWAY
CAMBRIDGE, MASSACHUSETTS
HVAC REPLACEMENT PROJECT
HVAC BASEMENT & FIRST FLOOR NEW WORK PLANS

RUSSO BARR
CONSULTANTS
35 Devon Street, 2nd Floor, Burlington, MA 01803

NO	DATE	BY	DESCRIPTION

DIVISION 15

SECTION 15500

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.01 GENERAL

- A. The General Conditions of the Contract for Construction and the General Requirements are hereby made part of this specification. The Public Notice to Bidders, Instructions to Bidders, Schedule of Contract Drawings, Bidders Proposal, Alternates, Form of Contract, Form of Payment Bond, Form of Performance Bond, General and Supplementary Conditions and SCME - Supplementary Conditions for Mechanical and Electrical Trades are hereby made a part of specifications for this division, with like force and effect as if set forth therein at length.
- B. The HVAC Contractor shall be considered the General Contractor for the extent of this project. All references to the Contractor, General Contractor and HVAC Contractor shall refer to the HVAC Contractor. The Contractor shall examine all Drawings and all Sections of the Specifications and shall be responsible for all work included. The Contractor shall be DCAM certified for heating, ventilation and air conditioning work.

1.02 LOCATION

- A. The Work of this Contract shall be performed at the Solomon Transportation Career Center in Cambridge, Massachusetts.

1.03 SCOPE OF WORK

- A. The work under this Section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, in general, to include the following items:
 - 1. Demolition of existing boiler, trim and accessories.
 - 2. Demolition of existing boiler flue and guy wires.
 - 3. Removal of existing fuel oil tank.
 - 4. Provide two (2) gas fired, steam boilers; boiler feed unit; combustion air provision; ductwork; boiler breeching from boiler to existing chimney; piping; steam traps; insulation; valves; automatic temperature controls; and appurtenances indicated on the contract drawings for the heating system renovations
 - 5. Galvanized Sheet Metal Duct System
 - 6. Duct Insulation

7. Testing and Balancing of Air System
 8. Vibration Isolation
 9. Provide automatic temperature controls including but not limited to:
 - a. Removal of controls related to the demolition of existing equipment
 - b. Installation of new boilers as shown on the Drawings and called for in this Specification
 10. Cutting and Patching
 11. Firestopping
 12. Seismic Provisions
- B. Furnish all labor and materials to perform demolition work as shown on the Drawings, as required for the installation of new work, and as specified hereinafter.

1.04 CODES, ORDINANCES, AND PERMITS

- A. Installation of systems and equipment provided under this section shall be done in strict accordance with Massachusetts Department of Public Safety Codes, Massachusetts Department of Environmental Protection, Massachusetts State Building Code and City of Cambridge Regulations having jurisdiction.
- B. All pressure vessels shall conform to ASME and Massachusetts codes and regulations.
- C. All work, where applicable, shall conform to NFPA codes and all material shall be U.L. approved.
- D. All electrical apparatus furnished under this section shall be approved by the U.L. and shall be so labeled or listed where such is applicable. Where custom-built equipment is specified and the U.L. label or listing is not applicable to the completed product, all components used in the construction of such equipment shall be labeled or listed by U.L. where such is applicable to the component.
- E. Give notices, file plans, obtain permits and licenses, pay fees and obtain necessary approvals from authorities having jurisdiction. Deliver certificates of inspection to Engineer. No work shall be covered before examination and approval by Engineer, inspectors, and authorities having jurisdiction. Replace imperfect or condemned work conforming to requirements, satisfactory to Engineer, and without extra cost to the Owner. If work is covered before due inspection and approval, the installing contractors shall pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

1.05 RECORD DRAWINGS

- A. Refer to DIVISION 1 of the Specifications for record drawings and procedures to be provided under this section.

1.06 CLEANING

- A. During the progress of the heating, ventilating and air conditioning work, Contractor shall clean up and remove all oil, grease and other debris caused by the Contractor. At completion, the Contractor shall clean all equipment, piping and duct systems and leave all work in perfect operating condition.

1.07 COORDINATION AND RESPONSIBILITY

- A. The structure and its appurtenances, clearances and the related services, such as plumbing, heating, ventilation and electric service have been planned to be legal, adequate and suitable for the installation of equipment specified under this section. The Owner will not assume any increase in cost caused by differing requirements peculiar to a particular make or type of equipment, and any incidental cost shall be borne by the Contractor. He shall be responsible for the proper location of his required sleeves, chases, inserts, etc., and see that they are set in the forms before the concrete is poured. He shall be responsible for his work and equipment furnished and installed by him until the completion and final acceptance of this contract, and he shall replace any work which may be damaged, lost or stolen, without additional cost to the Owner.

1.08 PROTECTION OF MATERIALS, WORK, AND GROUNDS

- A. Materials, fixtures and equipment shall be properly protected and all pipe and duct openings shall be temporarily closed so as to prevent obstruction and damage.
- B. Protect and preserve all materials, supplies and equipment of every description and all work performed. Protect all existing equipment and property of any kind from damage during the operations. Damage shall be repaired or replaced promptly by the Contractor at his expense.

1.09 DRAWINGS

- A. It is the intention of the Specifications and Drawings to call for finished work, tested and ready for operation. Any apparatus, appliance, material or work not shown on the Drawings, but mentioned in the Specifications or vice-versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by the Contractor without additional expense to the Owner.
- B. The Drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the project and shall have the approval of the Engineer before being installed. The Contractor shall follow Drawings, including his shop drawings, in laying out work and shall check the Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Engineer before proceeding with the installation. The Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

- C. Size of pipes and methods of running them are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the Drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge. All work shall be installed in such a manner as to avoid being unsightly.
- D. All measurements shall be taken at the building by the Contractor, prior to purchasing and installing the equipment and piping.

1.10 SHOP DRAWINGS

- A. Provide five (5) sets of shop drawings for the following in accordance with Division 1:

- 1. Boilers/Burner Unit and Burner Control Panels, each size
- 2. Boiler Feed Unit, each size
- 3. Combustion Air Louver
- 4. Breeching
- 5. Chimney Liner
- 6. Supports
- 7. Strainers
- 8. Thermometers and Gauges
- 9. Pipe and Pipeline Accessories
- 10. Valves, each type
- 11. Steam Traps
- 12. Insulation, each type
- 13. Thermostatic Valves
- 14. Automatic Temperature Controls components complete with wiring diagrams
- 15. Sequence of Controls
- 16. Sheetmetal Standards
- 17. Sheetmetal Shop Drawings
- 18. Vibration Insulation
- 19. **Draft Control Systems**

6-13-14

1.11 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Provide Record Drawings of the installed system in accordance with Division 1- General Requirements. Record Drawings will be provided in both paper and electronic (AutoCAD Release 2014) copies to the owner.

1.12 UNDERWRITERS' LABEL AND LISTING

- A. All electrical apparatus furnished under this Section shall be approved by the UL and shall be labeled or listed where such is applicable. Where custom-built equipment is specified and the UL label or listing is not applicable to the completed product, all components used in the construction of such equipment shall be labeled or listed by UL where such is applicable to the component.

1.13 CUTTING AND PATCHING

- A. All cutting and patching necessary for the proper installation of work to be performed under this Section and subsections shall be performed by the Contractor.
- B. All work shall be fully coordinated with all phases of construction, in order to minimize the requirements for cutting and patching.
- C. The Contractor shall form all chases or openings for the installation of his own or any other Contractor's or Subcontractor's work, or shall cut the same in existing work and shall see that all sleeves or forms are in the work and properly set in ample time to prevent delays. He shall see that all such chases, openings, and sleeves are located accurately and are of the proper size and shape and shall consult with the Engineer and the Contractors or subcontractors concerned in reference to this work. In so doing, he shall confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall piers or structural members be cut without the approval of the Engineer.
- D. The Contractor shall carefully fit around, close up, repair, patch, and point around the work specified herein to the entire satisfaction of the Engineer.
- E. The Contractor shall fill and patch all openings or holes left in the existing structures by the removal of existing equipment by himself, his subcontractors or other filed subcontractors.
- F. All of this work shall be carefully done by workmen competent to do such work and with the proper and smallest tools applicable.
- G. Any cost caused by defective or ill-timed work shall be borne by the contractor responsible therefore.

1.14 GUARANTEE

- A. The Contractor shall guarantee, in writing, all work and all materials provided under this Section 15500, in accordance with the provisions of the printed form of Contract and the General Conditions.

1.15 ELECTRICAL

- A. All electrical apparatus and controls furnished as a part of this Section shall conform to applicable requirements of the National Electric Code.
- B. All motors furnished under this Section shall be furnished by the manufacturer of the equipment served and shall be mounted and aligned so as to run free and true. Each motor shall be built to conform to the latest applicable NEMA, ANSI and IEEE standards for the type and duty of service it is to perform.
- C. Each motor shall be designed to operate on 60 Hz, and each shall be expressly wound for the voltage specified. Each motor shall operate satisfactorily at rated load and frequency with a voltage variation no greater than plus or minus 10 percent of voltage specified. Dual voltage 208/220 motors will not be accepted.
- D. All motors shall be provided with adequate starting and protective equipment as specified, and each shall have a terminal box of adequate size to accommodate the required conduit and wires.
- E. Motor controllers shall be equipped with all poles, auxiliary contacts and other devices necessary to permit the interlocking and control sequences required. Controller operating coils shall be generally designed for 120 volt operation, and 3 phase motors shall be provided with thermal overload protection in all phases.
- F. The Contractor shall furnish and install all magnetic starters for each and every motor furnished under this section of the specification, except where otherwise indicated.
- G. The Contractor shall furnish and install all low voltage and/or line voltage control wiring for all mechanical equipment provided under this section. All control wiring shall be installed by a licensed electrician.

1.16 VERIFYING EXISTING CONDITIONS

- A. Before commencing any work under this section, verify all governing dimensions and examine all adjoining work on which this work is in any way associated or connected. Failure to visit the jobsite will in no way relieve the Contractor from installing the work according to the intent of these specifications and at no additional cost to the Owner.
- B. Each bidder shall visit the site and inspect conditions affecting the proposed work. Failure to do so and misinterpretation of the Plans and Specifications resulting from failure to visit the site shall be entirely the responsibility of the bidder.
- C. Each bidder shall make note of the existing conditions affecting hauling, rigging, transportation, installation, etc., in connection with his work and shall make all provisions for transportation of all materials and equipment.
- D. Where field conditions require, the Contractor shall arrange for equipment to be shipped to the job, dismantled and assembled in place.
- E. Remove walls, window assemblies/glass and floor structures where necessary to install and remove equipment as shown. The Contractor shall reinstall such displaced structures to their original condition.

1.17 STANDARDS

A. The latest published issue of the standards, recommendations, or requirements of the following listed societies, associations, or institutes in effect at the date of Contract are part of this Specification. These shall be considered as minimum requirements; specific requirements of this specification and/or associated drawings shall have precedence. In case of conflict between published requirements, the Owner's representative shall determine which is to be followed.

1. AMCA Air Moving and Conditioning Association
2. ANSI American National Standards Institute
3. ASHRAE American Society for Heating, Refrigerating, and Air Conditioning Engineers
4. ASME American Society of Mechanical Engineers
5. ASTM American Society for Testing and Materials
6. FIA Factory Insurance Association
7. IEEE Institute of Electrical and Electronic Engineers
8. MCAA Mechanical Contractors Association of America
9. NEMA National Electrical Manufacturers Association
10. NFPA National Fire Protection Association
11. SMACNA Sheet Metal and Air Conditioning Contractors' National Association
12. UL Underwriters' Laboratories, Inc.
13. OSHA Occupational Safety and Health Act
14. NEC National Electric Code

1.18 COOPERATION WITH OTHER TRADES

- A. The work shall be so performed that the progress of the entire building construction, including all other trades, shall not be delayed or interfered with. Materials and apparatus shall be installed as fast as conditions permit and must be installed promptly when and as desired.
- B. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections. Any conflicts shall be referred immediately to the Engineer for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Engineer's satisfaction, at no expense to the Owner.

1.19 WORKING CONDITIONS AND SAFETY

- A. Whereas the Solomon Building may be occupied during the construction period, it is of utmost importance that the occupant's safety and the building's use be maintained. The Contractor shall not disrupt the normal operations of the building and shall be required to cease work during occupied hours if, in the opinion of the Owner, the work creates a disruption to the building's use. The Contractor will then be required to perform such disruptive work during non-occupied hours.

1.20 FINAL ACCEPTANCE

- A. Final acceptance of Ownership of the HVAC system installed within this scope of work shall be contingent on passing a satisfactory system pressure test, mechanical performance test and cooling and heating function test to determine that the system will perform according to the contract requirements. The above tests shall be witnessed by the Engineer and the Owner at his option and acceptance will only be granted in writing by the Owner after receipt of certification from the Engineer that the design criteria have been met.

1.21 SEISMIC RESTRAINT REQUIREMENTS

- A. For each seismic restraint, provide certified calculations to verify adequacy to meet the following design requirements:
 - 1. Ability to accommodate relative seismic displacements of supported item between points of support.
 - 2. Ability to accommodate the required seismic forces.
- B. For each respective set of anchor bolts provide calculations to verify adequacy to meet combined seismic-induced shear and tension forces.
- C. For each weldment between structure and item subject to seismic force, provide calculations to verify adequacy.
- D. Calculations shall be stamped by a professional engineer who is registered in the Commonwealth of Massachusetts and has specific experience in seismic calculations.
- E. Restraints shall maintain the restrained item in a captive position without short circuiting the vibration isolation.
- F. Provide seismic restraints for all piping, ductwork and equipment in accordance with the requirements of the Massachusetts State Building Code, 780 CMR, 8th Edition, and referenced requirements of BOCA and NFPA.

PART 2 - PRODUCTS

2.01 BOILER/BURNERS

- A. Furnish and install one (1) low pressure, wet base, cast iron sectional boiler with power burner that pressurize the firebox and operate under forced and balanced draft.

Manufacturers shall be Smith Boiler, Weil McLain 88 Series, Burnham or Approved Equal.

- B. Assemble and install boiler-burner unit(s) in compliance with manufacturer's installation instructions. All work must be done in a neat and workman like manner.
- C. Provide low pressure steam boilers with burners with capacity as indicated on contract drawings.
 - 1. Boiler-burner unit Field assembled (standard).
 - 2. Burner shall be provided with Auto Flame combustion control.
- D. Boiler(s) shall have I=B=R Hydronics Institute gross output(s) at 100% firing rate as indicated on contract drawings.
- E. Boiler(s) shall be manufactured by ISO 9001 registered company to conform to Section IV of the ASME Boiler and Pressure Vessel Code.
 - 1. Individual sections (and section assembly) to be hydrostatically pressure tested at factory in accordance with ASME requirements.
 - 2. Maximum allowable working pressure 50 PSIG water and 15 PSIG steam cast as part of section with ASME symbol. (Water only: optional 80 PSIG stamped in section in place of 50 PSIG).
- F. Regulatory Requirements
 - 1. Boiler(s) and controls to comply with applicable regulations.
 - 2. Provide UL labeled burner(s).
 - 3. Applicable Massachusetts State Building Code Requirements.
- G. Submittals
 - 1. Submit shop drawings and product data.
 - 2. Submittal packet to include boiler (and burner) manufacturer descriptive literature, installation instructions, operating instructions, and maintenance instructions.
- H. Boiler Construction
 - 1. Boiler sections.
 - 2. Assembled with short, individual draw rods.
 - 3. Cast with sealing grooves for high temperature sealing rope to assure permanent gas-tight seal.

4. Sealed water-tight by elastomer sealing rings, not cast iron nipples. Each port opening is machined to completely capture sealing ring between sections.
5. Must be hydro-wall design to provide completely water-cooled combustion chamber.
6. Provided with sufficient tapings to install required controls.
7. Limited 10 year warranty against workmanship and defects to be in writing by manufacturer.

I. Boilers

1. Provided with cast-in air elimination to separate air from circulating water.
2. Constructed to provide balanced water flow through entire section assembly using single supply and return connections for water. No external headers are necessary for water. Steam requires an external header 24" minimum from the waterline to the bottom of the header.
3. Designed with a low silhouette to provide maximum headroom.
4. Furnished with insulated burner mounting plate having necessary holes and tapings to mount burner. High temperature sealing rope is used to provide permanent gas-tight seal between front section and plate.
5. Furnished with two observation ports (one in front and one in back) to allow visual inspection of the flame.
6. Provided with cast iron flue collar with a built-in adjustable damper capable of being locked into place after adjustment.
7. High temperature sealing rope used to provide permanent gas-tight seal between hood and section assembly.
8. Furnished with cast iron cleanout plates to cover cleanout openings on the front of the boiler(s).
9. Elastomer sealing rings are to be used to provide permanent water-tight seal between sections. Unlike cast iron or steel push nipples, the elasticity of the seals fills any gaps caused by misalignment or expansion or contraction.
10. Shipped with insulated heavy gauge steel jacket(s) with durable powdered paint enamel finish. Jacket designed to be installed after connecting supply and return piping.

J. Boiler foundation

1. Installer to construct concrete foundation as shown in drawings.

K. Boiler Trim

1. All electrical components to be of high quality and bear the UL label.
 2. Steam boiler standard controls furnished:
 - a. Low pressure control (operating) and high pressure control set at maximum pressure as a safety control.
 - b. Steam pressure gauge with dial clearly marked and easy to read.
 - c. Gauge cock water set with gauge glass, guards and aluminum water level plate.
 - d. ASME certified pressure relief valve, set to relieve at 15 PSIG. Side outlet discharge type; contractor to pipe outlet to floor drain or near floor, avoiding any area where freezing could occur.
 3. Low water cut-off for steam boiler(s):
 - a. Boiler(s) to be furnished with UL labeled low water cut-off with ASME working pressure rating equal to the ASME rating of the relief valve.
 - b. Do not use quick-connect fittings on boiler(s).
 - c. Install cut-off according to manufacturer's instructions.
 - d. Locate so burner shuts down if boiler water level falls below allowable safe waterline (steam boilers, 1/4" above bottom of gauge glass).
 - e. Steam boiler primary low water cut-off shall be a float type – auto reset.
 - f. Steam boiler secondary low water cut-off shall be a float type – manual reset.
- L. Burner construction, features and requirements:
1. Burner fuel supply system and burner installation to conform to burner manufacturer's installation instructions and applicable codes.
 2. Burner motor characteristics: 240/60/1
 3. Control characteristics 120/60/1.
 4. Burner fuel – natural gas.
 5. Provide Massachusetts approved Gas Burner.
 6. Burner to have UL label supplied by the burner manufacturer.
 7. Burner designed to ensure high efficiency and good performance under forced draft conditions with 0.1" W.C. positive pressure at the flue collar.
 8. Burner to be adjusted to provide 9.5 to 10.0% CO₂ for gas.

9. Burner(s) manufactured by: Power Flame with capacities as indicated on contract drawings and Auto Flame combustion control technology.
 10. Burner operating mode: low-high-low
- M. Panel options – power on/fuel on light is standard on all burner(s) with panels. Panel shall be capable of providing lead/lag operation of boilers to maintain steam header pressure controls.
1. Call For Heat
 2. Ignition On
 3. Pilot Failure
 4. Low Water
 5. Flame Failure
 6. Silencing Switch
 7. Control Fuse and Holder
 8. Post Purge Timer
 9. Alarm Bell
 10. Manual – Autoswitch
 11. Auxiliary alarm contacts for interconnection with new building EMS
- N. Start-up and Service
1. The contractor shall obtain the services of a factory authorized agent to provide burner light-off and adjustment. The start-up agent shall provide a burner light-off report as written proof that the burner was adjusted to optimum performance.
 2. Authorized: The agent shall provide a one year service warranty after start-up.

2.02 PIPE AND FITTINGS

- A. Furnish all pipe and fittings required for the HVAC systems, including steam supply (LPS), steam condensate return (LPC), boiler blow down (BBD), boiler feed (BF), vent piping (V), hot water supply, pumped condensate (PC) and cold water make-up piping.
- B. Low Pressure Steam Supply (LPS), Boiler Feed (BF) and Vent Piping (V): All steam piping shall be Schedule 40 black seamless steel pipe, shall be sized as indicated on Drawings, and shall conform to ANSI B-36.10 and ASTM A-53, grade A or B. Fittings for pipe sizes 2-½ inches and above shall be steel, with butt-welding ends. Fittings for pipe sizes 2 inches and below shall be threaded 300-pound malleable iron or forged steel.

- C. Low Pressure Condensate (LPC), Pumped Condensate (PC) and Boiler Blow Down Piping (BBD): All condensate return, drain, blowdown, draw-off, relief vent, pumped condensate and boiler feed piping shall be Schedule 80 black steel pipe conforming to ANSI B-36.10 and ASTM A-53, grade A or B. Fittings for pipe sizes 2-½ inches and below shall be threaded 300 pound malleable iron or forged steel. Joints shall be welded for pipe sizes 2-½ inches and above, threaded for pipe sizes 2 inches and below.
- D. Unions for use with steel piping shall be 300 pound malleable iron, ground joint, or 2,000 pound forged steel, 600 psi WOG, sweat or thread end as required. Unions for copper pipe shall be bronze, ground joint, 600 psi WOG, sweat or thread end as required.
- E. Non-potable water makeup piping shall be Type L copper tubing with wrought copper fittings, 95-5 soldered, shall be sized as indicated on Drawings, and shall conform to ANSI H-23.1 and ASTM B-88.
- F. Provide dielectric unions at all connections of dissimilar metals. Dielectric unions shall be factory certified to withstand a minimum of 600 volts on a dry line with no flashover, rated 250 psig and conforming to ANSI B16.39. Dielectric union and flange pipe threads shall conform to ANSI B2.1.

2.03 PIPE HANGERS, SUPPORTS, INSERTS

- A. Carpenter and Patterson, Grinnell, Calco, or approved equal. Figure numbers listed are Carpenter and Patterson numbers.
- B. General: Piping systems shall be supported in accordance with ANSI B31.1 so as to maintain required pitch of lines, prevent vibration, and provide for expansion and contraction movement.
- C. Piping hangers and supports shall be furnished and installed for piping. Provide all components (i.e., inserts, rods, clamps, hangers, washer, lock nuts, rollers, etc.) necessary for a complete installation.
- D. Hangers:
 - 1. Hangers for all low pressure steam, low pressure condensate, boiler feed, vent, hot water supply and hot water return piping shall be Figure 140 adjustable roll hangers for pipe sizes 4" and larger; and Clevis figure 100 for piping 3" and smaller.
 - 2. Hangers for all other piping shall be Figure 1A Bands.
 - 3. All hangers shall be with supporting rods and nuts. Rod sizes shall be as follows:

Hangers for pipes 6" and larger	3/4"
Hangers for pipes 4" and 5"	5/8"
Hangers for pipes 2 ½" and 3"	1/2"
Hangers for pipes 2" and smaller	3/8"
 - 4. Pipe covering protection saddles shall be Series 350 galvanized steel and shall be furnished for installation at each hanger where pipes are insulated.

- E. Upper Attachments to Building Structure:
1. Reinforced Concrete Construction: Upper attachment welded or clamped to steel clip angles which are expansion-bolted to the concrete. Expansion bolting shall be located so that piping loads place bolts in shear.
 2. Structural Framing: Upper attachments welded or clamped to structural steel members. Additional steel members may be necessary in some support locations where piping locations differ from that known on contract drawings.
 3. Submit details for approval.
- F. Expansion Fasteners and Power Set Fasteners: In concrete ceiling construction, expansion fasteners may be used for hanger loads up to one-third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one-fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.

2.04 SLEEVES

- A. Furnish pipe sleeves for all pipes which pass through masonry floors and walls. Sleeves shall be Schedule 10 steel pipe. Sleeves shall be of the first possible size larger than the outside of the insulation jacket on covered piping and the first possible size larger than the outside of the piping on uncovered pipes.
- B. Sleeves shall be of sufficient length so as to be flush on either side of masonry walls, flush on underside of masonry floor and extend 2" above the finished floor.

2.05 ESCUTCHEON PLATES

- A. Escutcheon plates shall be chromium plated, cast brass split type escutcheons.

2.06 VALVES

- A. Gate valves, globe valves, check valves and drawoff valves shall be Powell, Lunkenheimer, Crane, or approved equal. Figure numbers herein are Powell numbers.
1. Gate valves 2-½" and larger shall be Figure 1793, 125#, I.B.B.M., solid wedge, O.S.&Y., rising spindle, flanged end. Provide chain operators for all valves above 6'6" above finished floor level.
 2. Globe valves 2-½" and larger shall be Figure 241, 125#, I.B.B.M., O.S.&Y. with regrind - renew beveled bronze disc and seat ring, flanged end.
 3. Check valves 2-½" and larger shall be Figure 559, 125#, I.B.B.M., horizontal swing type, with regrind-renew bronze seat ring and disc, flanged end.
 4. Check valves 2" and smaller shall be Figure 578, 125# bronze, horizontal swing type with regrinding bronze seat and disc, screwed end.
 5. Draw-off valves shall be Figure 503H, bronze, screwed inlet, hose outlet.

- B. Valves 2" and smaller shall be ball valves. Ball valves shall be Jenkins Figure 32-A, Crane, Stockham or approved equal, bronze ball valves with bronze ball, Teflon seats, brass stem and cadmium plated steel handle with plastic grips.

2.07 THERMOMETERS AND PRESSURE GAUGES

- A. Thermometers and pressure gauges shall be Terrice, Ashcroft, Taylor or approved equal complete with all required wells. Model numbers used are Terrice numbers.
- B. Thermometers shall be Model BX9, industrial thermometers, adjustable angle, 9" case. Thermometer ranges shall be 0 °F to 100 °F for use in chilled water piping.
- C. Pressure gauges shall be Model 500 X with 4-½" case. Ranges shall be 0 to 100 psi. Furnish a Model 865 gauge cock with each gauge.

2.08 DUCT INSULATION

- A. Furnish all insulation required for combustion air intake duct.
- B. Insulation shall be Owens-Corning, Knauf, Certainteed, or approved equal.
- C. Duct Insulation, Interior: Insulate the ductwork with 1.5 inch thick, 3/4 lb. density fiberglass duct insulation, ASTM C533, maximum service temperature 450°F, with factory applied flame retardant PSK facing (UL labeled).
- D. Fiberglass insulation shall meet ASTM C 335 for thermal efficiency.
- E. Ends of insulation shall be sealed with material as recommended by the manufacturer.
- F. A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces.
- G. Fire Hazard Rating: Insulation materials, coatings and other accessories shall individually have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed. Ratings shall be determined by U.L. "Test Method for Fire Hazard Classification of Building Materials", No. 823 or NFPA No. 225 or ASTM E84.

2.08 PIPE INSULATION

- A. Manufacturers: Owens-Corning, Knauf, Certainteed, or equal.
- B. All tanks, equipment and piping in the mechanical room and breeching, as noted on the drawings, within the Boiler Room shall be insulated under this Section.
- C. Furnish and install all insulation required for the systems including, but not necessarily limited to, pipe insulation for steam, condensate return, condensate transfer, boiler feed and non-potable water, breeching/boiler smokehoods and boiler feed tank.
- D. Boilers shall be furnished with insulation by the manufacturer.
- E. The following equipment, piping, valves and fittings shall not be insulated:

1. Gas Piping
2. Blowdown Piping
3. Unions
4. Dielectric Flanges and Unions
5. Water Column Piping and Blowdown
6. Low Water Cutoff Piping and Blowdown
7. Safety Valves and Vent Piping
8. Strainers
9. Flexible Connections

F. Materials: Insulation materials shall be in accordance with the following:

1. Pipe, Flanged Fittings and Flanged Valves: Fiberglass Fed. Spec. HH-1-558B, Form D, Type III, Class 13, high density, to 850 °F., ASTM C 335 for thermal efficiency.
2. Welding Fittings: Fiberglass Fed. Spec. HH-1-558, Type 1, Class 7, with polyvinyl chloride fitted covering, Fed. Spec. L-P-535, Composition A, Type II, ASTM 335 for thermal efficiency.
3. Boiler Feed Tank, Calcium Silicate Blocks, Mil. Spec. Mil-1-2819, Class 1, rated for 1200°F.
4. Insulating and Finishing Cements: Best grade as recommended by manufacturer for type of insulation system and service conditions.
5. Bands: Japanned or galvanized; 0.015 inch thickness and 1/2-inch wide; 16 gauge galvanized or copper coated steel wire; hexagonal mesh as required by application.
6. All Purpose Jacket: Fed. Spec. HH-B-100B, Type 1, with double sided pressure sensitive adhesive closure.
7. Jackets:
 - a. Aluminized Glass Cloth: Laminated to Aluminum Foil, 10 Ounces minimum per square yard
 - b. PVC: PVC jackets shall meet ASTM D1784, Class 14253-C; have a flame spread of 25 or less have a smoke developed rating of 40 or less. PVC jackets shall be joined by applying continuous PVC cement along all seams. PVC jackets will be required for all new pipe insulation in boiler room, color as selected by the Engineer.

c. PVC jackets shall be provided for all new and existing to remain heating /plumbing piping in each boiler room; jacket shall be color coded, as determined by engineer, for piping identification.

8. Adhesives, Joint and Lap Tapes: Manufacturers' standard for the insulation applied and fully compatible with all materials applied in the system. Adhesive for application of glass cloth and/or aluminized cloth covering shall be nonflammable wet and meet fire spread specification dry.

9. All material incorporated in the job shall be identified on manufacturers' container by name, type and description.

10. Fire and Smoke: Assembled systems shall meet flame spread 25 and smoke developed 50 ratings as developed under ASTM, E84, NFPA No. 225 and UL No. 823 standard and specifications.

G. Pipe insulation thickness and type shall be in accordance with the following:

1. Insulation on all new and existing to remain piping including steam, boiler feed, condensate return, condensate transfer, non-potable make-up water, etc., shall be fiberglass with all service jacket and self-sealing lap. Thicknesses shall be:

PIPE DIAMETER	INSULATION THICKNESS
1 ½ inch and below	1 ½ inch
2 inch and larger	3 inch

2. Boiler Feed Tank insulation and type shall be in accordance with the following:

SYSTEM	THICKNESS	JACKET
Boiler Feed Tank	2 inches	Aluminized Glass cloth

3. Insulation for cold water and non-potable water piping shall be 1" closed cell elastomeric insulation with heat transfer not to exceed .28 BTU/hr/ft/°F/inch.

H. The Contractor must visit the site to determine the extent of existing piping, etc., because all of the existing systems are not shown on the drawings. The Contractor shall be responsible for determining the quantities of insulations required to meet the full intent of this Section.

2.09 BREECHING AND FLUE

A. Boilers:

1. Furnish and install a dual wall insulated breeching/stack system sized in accordance with the 2009 International Mechanical Code.

2. Breeching to be round, double wall, all metal, gas and liquid-tight factory built component system, tested and listed by UL for use with building heating equipment, burning gas, solid or liquid fuels as described in NFPA-85A, B, D and NFPA-211.
3. Breeching inner shell (gas carrying pipe) to be 0.035" 316 stainless steel. Outer shell to be 0.026" 304 stainless steel. Both inner and outer shell construction to be all welded (tacked joints are unacceptable) and all vertical seams to be full strength 100% penetration square groove weld in accordance with AISC and/or AWS specifications and codes. Inner and outer walls to be connected by "J" clips, which shall allow for unobstructed thermal expansion of inner and outer walls.
4. Insulating barrier to consist of two (2) inches of six (6) pounds per cubic foot density insulation secured to the inner shell with steel straps.
5. Inner shell to be sealed by use of 304 stainless steel bands and high-temperature sealant. The outer shell to be joined together with sealant and one piece 304 stainless steel draw bands. Joint sealant to be supplied by the manufacturer for the anticipated temperature range.
6. System to be complete with elbows, tees, laterals, tapered increasers/reducers, thimbles, support plates, expansion sections, flange adapters, boiler kits, and all necessary hangers, guying and supports. Final system design/layout to be by breeching manufacturer. Submit shop drawings to the Engineer for approval.
7. System to be warranted against defects in materials and workmanship for a period of twelve (12) years from date of original installation.

2.10 STRAINERS

- A. Provide a "Y" type full size strainer as indicated on the Drawings.
- B. An approved dirt blowout connection shall be made to each strainer, with 1" Jenkins Figure 372 and Figure 658 cap and chain; the valve located six inches to twelve inches below the strainer. In the case of strainers under full water pressure, the blowout connection shall terminate at a point where there will be no risk of flooding or damage.
- C. Strainers 2 inch diameter and smaller shall have screwed ends. Strainers 2-1/2 inch diameter and larger shall have flanged ends.
- D. Strainers 2 inch and smaller shall be full size, bronze, "Y" pattern: Tate Temco Figure 1Y, Spirax Sarco, Mueller or approved equal.
- E. Strainers 2-1/2" or larger shall be cast steel body, "Y" type; Tate Temco figure 1Y, Spirex Sarco, Mueller or approved equal, 150 psi rating.
- F. Total open area of basket perforations shall be at least three times the inside area of pipes.
- G. Strainer baskets shall be stainless steel with 1/16" perforations (up to 2" size) and 1/8" perforations (2-1/2" and larger).

2.11 VIBRATION ISOLATION

A. General

1. All vibration isolators shall be the product of a single approved manufacturer.
 2. Model numbers hereinafter specified are from Mason Industries. Other equivalent units by Consolidated Kinetics, Vibration Mountings and Controls or approved equal are acceptable.
- B. All vibration isolators for mechanical equipment hung in ceiling shall be selected in accordance with the weight distribution of the equipment to be served so as to produce a uniform deflection. Deflections shall be as hereinbefore specified.
- C. Submittals shall include all spring deflections, spring diameters, scale drawings, attachment details, and rated capacity indicating adequacy for each piece of equipment served.

2.12 STEAM TRAPS

- A. Provide and install all new traps as indicated on the drawings. Traps shall be Armstrong, Sarco, Barnes & Jones or equal.
- B. Float and thermostatic traps shall have heavy-duty cast-iron body and cover, stainless steel valve plug, seat, and float, and one piece stainless steel thermostatic cage unit for air removal. Trap to have multiple-location inlet and outlet tappings.
- C. All new thermostatic-type traps shall have forged carbon steel bodies and be capable of steam pressure ranges from vacuum to 250 psig and temperatures to 850°F without adjustment or orifice change. Traps shall have integral stainless steel strainer, stainless steel ball valve and stainless steel seats. Traps shall operate on the heat-pressure principle with free floating ball valve on downstream side of seat and shall close if backpressure exceeds steam supply pressure. Steam traps to be of the multi-segmented bimetallic element type. All internal operating parts shall be assembled as a cage unit allowing rapid and easy removal for replacement. Bellows-type traps will not be acceptable.

2.13 THERMOSTATIC VALVES

- A. Two pipe low pressure steam systems: Provide thermostatic radiator control valve for two pipe systems. Valve shall be nickel plated brass with EPDM valve disc, stainless steel spring, brass valve spindle, phosphor-bronze bellow and ABS handle. Provide valve with tamper resistant valve mounted sensor and/or remote sensor as required.

2.14 SUPPLY FAN

- A. Furnish and install a roof mounted supply fan as shown and scheduled on the drawings and as specified herein. Fan shall be direct drive, down blast type of spun aluminum with permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

- B. Wheel shall be constructed of die formed aluminum blades riveted to a steel hub, statically and dynamically balanced in accordance with AMCA Std 204-05. The propeller shall have steeply pitched blades with matched fan inlet.
- C. Motors:
 - 1. Motor enclosure shall be open drip-proof: opening in the frame body and or end brackets
 - 2. Motors shall be permanently lubricated, heavy duty ball bearing type and furnished at the specific voltage and phase
 - 3. Mounted on vibration isolators, in the airstream
 - 4. Hub securely attached to the motor shaft with set screws
 - 5. Accessible for maintenance
- D. Leak proof housing/hood of aluminum construction with rigid internal support structure
- E. Housing supports shall be constructed of heavy gauge, zinc plated steel with birdscreen and single piece fan shroud of heavy gauge aluminum construction with rolled bead.
- F. Single piece lower windband of aluminum construction
- G. Motor Cover shall be of aluminum construction attached with stainless hardware
- H. Double studded true isolators
- I. NEMA rated disconnect switch with positive electrical shut-off wired from fan motor to junction box within motor compartment
- J. Curb caps of aluminum construction, including pre-punched mounting holes
- K. Provided with the following options/accessories:
 - 1. Galvanized steel bird screen
 - 2. Pitched roof curb (type GPPF) of galvanized construction, with flashing flange and minimum 1.5 inch insulation thickness. Curb height shall be minimum 24" above roof surface.
 - 3. Gravity damper balanced for minimal resistance to flow, galvanized frame.
 - 4. Speed Controller

2.15 BOILER FEED UNIT

- A. Furnish and install a boiler feeder unit as shown and scheduled on the drawings and as specified herein. Unit shall consist of:
 - 1. Cylindrical, multiple section steel receiver

2. Two (2) boiler feed pumps
 3. One (1) water make-up assembly.
 4. Starters factory-mounted and wired
 5. Gauge glass and shutoff/drain valves
 6. Thermometer with 9" scale case and fully adjustable angle hinge assembly
 7. Basket-type strainer
- B. The boiler feed receiver: Steel with seal coating inside and out, equipped with water gauge glass with shutoff valves and guards, dial thermometer, and low water cutoff switch.
1. Receivers shall have net working capacity of not less than that shown on the drawings. Receivers shall be equipped with water gauge glass with shutoff valves and guards dial thermometer, low water cutoff switch, and heightless cradles. Receives to be equipped with safety release mechanism to relieve in the event of excess pressure. Gasketing between removable cast iron flanged cover shall be by means of minimum 0.5 inch O-ring cord, temperature range 40°F to 250°F in accordance with ASTM D200 5BG-715. Transport casters shall be provided by manufacturer on all horizontal units for jobsite placement. The receiver shall be guaranteed against failure due to corrosion for a period of 20 years.
- C. An inlet strainer with self-cleaning bronze screen and large dirt pocket shall be mounted on the receiver. The screen shall be vertically removable for cleaning, requiring no additional floor space for servicing.
- D. One (1) butterfly type suction isolation valve shall be factory installed between each pump and the receiver to permit servicing the pump without draining the receiver. Valve shall be of the type to allow complete removal of the pumps including the upper and lower half of the casing, for replacement of the wearing rings.
- E. Water make-up assembly shall consist of a level control switch mounted in the tank and an electric solenoid valve. Valve shall be packless, piston pilot-operated type with cushioned closing feature and epoxy resin molded waterproof coil. Valve shall be equipped with a strainer, and a 3-valve manual bypass for manually filling the tank in the event the solenoid valve fails. Water make-up capacity through the solenoid valve shall be equal to one boiler feed pump.
- F. Manufacturer to provide pre-piped discharge header assembly, including swing check valves, solenoid valves, flow balancing valves and all required fittings.
- G. Boiler Feed Pumps:
1. The boiler feed pumps shall be vertical, flange-mounted, centrifugal, 3500 RPM design, permanently aligned and factory assembled. Each pump shall be bronze fitted and have an enclosed bronze centrifugal impeller, renewable bronze case

- wear rings, stainless steel shaft and shall be close-coupled to a 3500 RPM drip proof motor.
2. Mechanical seals shall be suitable for 220°F operation. Each pump shall be able to deliver its full rated capacity at no more than 2'NPSH.
- H. The unit shall contain starters factory mounted and wired in NEMA 4X enclosures with interlocked hinged door containing the following:
1. One (1) Combination Magnetic Starter with Circuit Breaker for each pump
 2. Two (2) Boiler Feed Pump Selector Switches (Test/Off/Auto)
 3. One (1) Control Circuit Transformer when voltage exceeds 130 volts
 4. One (1) Numbered Terminal Strip
 5. One (1) Removable Control Mounting Plate
 6. One (1) Control Circuit Disconnect
 7. Two (2) Pump Running Pilot Lights
 8. Control cabinet shall contain U.L. listed or recognized components. Cabinet shall be listed by Underwriters Laboratories, Inc.
- I. Controls: Automatic Standby
1. Control components shall be provided by the unit manufacture, for operation as follows:
 - a. As the water level in the boiler recedes, the respective water column pump controller switch will close, starting the respective feed pump. As the level is restored, the switch will open and stop the pump.
 - b. If the water level in the boiler continues to drop, an auxiliary switch in the water column pump controller will close, starting the standby pump and simultaneously opening the respective solenoid isolation valve. An alarm shall sound, denoting standby pump operation. The standby pump shall continue to feed water into the boiler until normal boiler water level is restored. When the level is restored, the auxiliary switch shall open, stopping the standby pump and silencing the alarm.
 - c. Each boiler and its respective feed pump shall operate independently.
- J. The unit shall be factory tested as a complete package and shipped to the site unassembled. The unit manufacturer shall furnish complete elementary and connection wiring diagrams, piping diagrams, assembling instructions, installation and operating instructions.

2.16 DUCTWORK

- A. Furnish all sheet metal work and accessories specified herein.
- B. References to "Duct Manual" herein refer to the First Edition- 1995 - HVAC Duct Construction Standards as published by the Sheet Metal and Air Conditioning Contractor National Association, Inc.
- C. All ducts shall be of galvanized steel construction as specified. Ducts shall be properly stiffened to prevent drumming when the fans are in operation.
- D. Duct thicknesses shall be as follows:
 - 1. Longest duct dimension up to 12" - 26 gauge
 - 2. Longest duct dimension 13" through 24"- 24 gauge
 - 3. Longest duct dimension 25" through 30"- 22 gauge
 - 4. Longest duct dimension over 31" - 20 gauge
- E. Seal all duct joints (Class B) with EC-800 sealant as manufactured by Minnesota Mining Company, Foster, General Electric, or approved equal. Excess sealant must be removed immediately to provide a neat appearance.
- F. All ducts shall be fabricated for 2" water gauge pressure.
- G. All ducts shall be constructed in accordance with Table 1 and Figure 1-5 through 1-13 of the Duct Manual.
- H. Duct joints shall be constructed in accordance with Fig. 1-4 of the Duct Manual.
- I. Duct seams shall be constructed in accordance with Fig. 1-5 of the Duct Manual.
- J. Duct reinforcement shall be per Table 1-18, Figures 1-9, 1-10 and 1-11 of the Duct Manual.
- K. Fittings and special installations shall be constructed in accordance with Figure 2-1 through 2-10 of the Duct Manual.
- L. Hangers and supporting systems shall be in accordance with Figure 4-1 through 4-8 and Tables 4-1 through 4-3 of the Duct Manual.

2.17 BOILER CONTROL PANEL

- A. Boiler control panel shall be capable of operating and staging two steam boilers, regulating system supply pressure and monitoring condensate return temperature. The controller shall be provided with all necessary sensors and accessories for a fully operational system.
- B. Panel shall be capable of communicating with existing building automation system and provided with Bacnet interface.
- C. Panel shall be as manufactured by Tekmar, Honeywell, Heat-timer or approved equal.

2.18 AUTOMATIC TEMPERATURE CONTROL

A. Manufacturers:

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1. **Reliable Controls by Control Technology, Inc.**
2. Automated Logic
3. Siemens
4. Or equal.

B. Furnish and install all control components for stand-alone operation and to interface with the existing automatic temperature controls. This system of automatic temperature control shall be complete in all respects including all labor, materials, equipment and services necessary and shall be installed by personnel employed by the ATC Contractor.

1. Automatic temperature control system using field programmable micro-processor based units (Stand Alone Digital Controllers or SDC's, Application Specific Controllers or ASC's).
2. All control equipment to be fully proportioning, and the latest state of the art in manufacture and design.
3. The control systems to be installed by competent control mechanics and electricians under the supervision of the manufacturer of the control equipment. All control equipment to be the product of one (1) manufacturer and all ATC components to be capable of interfacing with the HVAC equipment. The factory trained control contractor must maintain adequate staff and offer standard services to fully support the Owner in the timely maintenance, repair, and operation of the control system. Contractors who do not maintain such staff and offer services or who must develop same for this project are not acceptable. Bids from franchised dealers as well as wholesale, distributor or representative type ATC contractors, or others whose principal business is not the manufacture, installation and service of temperature control systems will not be acceptable.

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4. ~~The Automatic Temperature Control (ATC) Contractor shall be the same contractor as the HVAC Maintenance Contractor for this project; sub-contracting Automatic Temperature Control work will not be allowed.~~ Contractor shall have a large support, technical and engineering staff on call 24 hours a day, located within 50 miles of the City of Cambridge. The ATC Contractor must support all hardware and software regardless of age. The ATC Contractor shall be "forward-backward" supportive. The software shall be extremely user friendly. Changes in programming must be made without having to rewrite the programming. Local branch/company/division must offer onsite and offsite computer operations training.

5. The operator interface shall be through a web based browser to a web hosted secure site; any operator shall be able to access the individual building energy

management system through any computer connected to the internet and a secure password.

C. Scope:

1. The control system provided to consist of all microprocessors, software, transformers, transducers, relays, thermostats, dampers, damper operators, valves, valve operators and all other necessary control components, along with a complete system, interlocking and communication wiring/cabling to fill the intent of the specification and provide for a complete and operable system.
2. Alarms, where applicable, and all interlocking wiring required to be provided by the ATC contractor.
3. The ATC contractor to review and study all HVAC and Electrical drawings and entire specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc., he has to provide.
4. All interlocking wiring and installation of all required control devices associated boilers, boiler feed units, condensate transfer pumps, etc., to be provided by the ATC contractor. Close coordination to be exercised between the ATC contractor and the HVAC contractor and equipment manufacturers so that installation will be provided in a manner to result in fully operable systems, as intended in these specifications.
5. The ATC contractor shall provide all power wiring, conduit, etc. for all his components requiring such. Provide power wiring from breakers in electric panels to ATC panels. All wiring to be done in strict conformance with the latest edition of the National Electric Code.

D. Incidental Work By Others:

1. The following incidental work to be furnished by the designated contractor under the supervision of the ATC contractor:
 - a. The HVAC contractor to coordinate required work with ATC and, without limiting the generality thereof, the work he is to perform for ATC to include the following:
 - 1) Install automatic valves, sensor wells and other similar equipment that are specified to be supplied by the ATC contractor.
 - 2) Furnish and install all necessary valved pressure taps, water, drain and overflow connections and piping.
 - 3) Provide, on magnetic starters furnished, all necessary auxiliary contacts, with buttons and switches in required configurations.
 - 4) Provide access doors or other approved means of access through ceiling and walls for service to control equipment.

E. Electric Wiring:

1. All electric wiring, wiring connections and all interlocking required for the installation of the temperature control system, as herein specified, to be provided by the ATC contractor, unless specifically shown on the Electrical drawings or called for in the Electrical Specifications, Division 16. Power to valves and actuators to be by the ATC contractor, except as specifically noted in the Electrical drawings and specifications.
2. All wiring and wiring methods to comply with the requirements of the Electrical Section of the specifications.
3. Provide, on magnetic starters, all necessary auxiliary contacts, with buttons and switches in required configurations.

F. Submittal Brochure:

1. In addition to the requirements of Division 1, the following to be submitted for Approval:
 - a. Control drawings with detailed piping and wiring diagrams, including bill of material and a written sequence of operation for each system controlled by the ATC contractor. Diagrams to include individual wiring and tubing marking designation, interlock details and wiring details of interfaces to other manufacturers system.
 - b. Panel layouts and nameplate lists for all local and central panels.
 - c. Valve and damper schedules showing size, configuration, capacity and location of all equipment.
 - d. Data sheets for all control system components.
 - e. Control strategies (software flow charts) must be included within the second ATC shop drawing submittal. The listing of each strategy must be in English and demonstrate the desired ATC sequence of operation. Submittal must be complete with proposed schedules, listing of setpoints and end device point listing and addresses.
 - f. Auto-Cad R-2014 compatible as-built drawings (DVD disks).
 - g. Upon project completion, submit operation and maintenance manuals, consisting of the following:
 - 1) Index sheet, listing contents in alphabetical order
 - 2) Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams
 - 3) Description of sequence of operations
 - 4) As-Built interconnection wiring diagrams
 - 5) Operator's Manual
 - 6) Trunk cable schematic showing remote electronic panel locations, and all trunk data

- 7) List of connected data points, including panels to which they are connected and input device (ionization detector, thermostat, etc.)
- 8) Conduit routing diagrams

G. Guarantee:

1. In addition to the guarantee requirements of the Contract and General Conditions, the Contractor shall obtain in the name of the Owner the standard manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. These guarantees are in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.
2. Upon completion of the installation, the ATC contractor shall submit to the Owner an agreement to provide the necessary programmed maintenance, to keep the various control systems in proper working condition, for a period of one (1) year commencing at final project acceptance. Additionally, this contractor to submit to the owner its standard agreement to support the system operation. This service must include operators support, application support, remote diagnostic support (via remote, on-line telephone support services) as well as database management support. This service shall be available 365 days per year, 24 hours a day.
3. The programmed maintenance agreement shall fully describe the maintenance work to be performed and shall advise as to the cost of this work prior to awarding of Contract.

H. Instruction and Adjustment:

1. Upon completion of the project, the ATC contractor to:
 - a. Fine-tune and "debug" all software control loops, routines, programs and sequences of control associated with the control system supplied.
 - b. Completely adjust and make ready for use, all transmitters, relays, damper operators, valves, etc., provided under this Section. This contractor shall furnish copies of complete, detailed, calibrating checkout and commissionary documentation for each controller.
 - 1) Documentation to list each procedure and shall be signed by the control specialist performing the service.
 - c. The ATC contractor shall provide an on-site training program for the Owner's staff in the operation and use of the control system. Training to include three (3) segments, as follows:
 - 1) Include 4 hours of classroom and hands-on training. This segment to instruct Owner's personnel in the system configuration, component characteristics, control strategy on each controlled system and all requirements for daily operation and use of the system. This segment to give the Owner's

representative a working proficiency in day-to-day operational requirements (i.e., system monitoring, alarm acknowledgment, HVAC system troubleshooting techniques, setpoint and time schedule adjustments, manual override, etc.).

- 2) All training to take place at the site and at times mutually agreed to between the ATC contractor and the Owner. The ATC contractor to provide to the Owner's designated representative, at least three (3) weeks before each segment, a course syllabus outline and schedule. The ATC contractor to provide all training material, reference material and training aids, as required, all as part of his Contract cost.
- 3) Provide a "User's Guide" for each room in the building for teachers and administration personnel for the operation of HVAC system in that room.

I. Communication:

1. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ASHRAE/ANSI Standard 135-2001, BACnet.
2. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
3. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - a. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - b. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 15900 Appendix A. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
4. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
5. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.

J. Controller Software:

1. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
2. Scheduling: System shall provide the following schedule options as a minimum:
 - a. Weekly: Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - b. Holiday: Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
3. System Coordination: Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
4. Binary and Analog Alarms.
5. Alarm Reporting.
6. Remote Communication: System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
7. Demand Limiting (Future interconnection to electric meter):
 - a. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.
 - b. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand. When demand drops below adjustable levels, system shall restore loads as specified.
8. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms indicated on the Sequence of Operation.
9. Sequencing: Application software shall sequence mechanical equipment as indicated on the contract drawings.
10. PID Control: System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall

calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

11. Staggered Start: System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
12. Energy Calculations:
 - a. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
 - b. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
 - c. System shall calculate a fixed-window average. Window interval start shall be defined by utility meter digital input signal to synchronize system's and utility's fixed-window averages.
13. Anti-Short Cycling: Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
14. On and Off Control with Differential: System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
15. Runtime Totalization: System shall provide an algorithm that can totalize runtime for each binary input and object. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 15900 (Sequence of Operations).

K. Equipment:

1. Controllers
 - a. General: Application Specific Controllers (ASC), and Smart Actuators (SA) as required to achieve performance specified in this section.
 - b. BACnet:
 - 1) NAE (Network Automated Engine): Each NAE shall have demonstrated interoperability during at least one BMA Interoperability Workshop & shall substantially conform to BACnet Building Controller (B-NAE) device profile specified in ASHRAE/ANSI 135-2001 BACnet Annex L.
 - 2) Advanced Application Controllers (AACs): Each AAC shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device

profile as specified in ASHRAE/ANSI 135-2001 BACnet Annex L.

- 3) Application Specific Controllers (ASCs): Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex Land shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
- 4) Smart Actuators (SAs): Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
- 5) BACnet Communication:
 - a) Each NAE shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link1 Physical layer protocol and BACnet IIP addressing.
 - b) BACnet routing shall be performed by NAEs or other BACnet device routers as necessary to connect NAEs to networks of AACs and ASCs.
 - c) Each AAC and ASC shall reside on a BACnet network using the ARCNET or MSITP Data Link1 Physical layer protocol.
 - d) Each SA shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.

c. Communication:

- 1) Service Port: Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
- 2) Signal Management: NAE and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
- 3) Data Sharing: Each NAE and AAC shall share data as required with each networked NAE and AAC.
- 4) Stand-Alone Operation: Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

d. Environment: Controller hardware shall be suitable for anticipated ambient conditions.

- 1) Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60 °C (-20°F to 140°F).

- 2) Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
 - e. Keypad: Provide a local keypad and display for each NAE and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not provide a keypad and display for each NAE and AAC, provide a Portable Operator's Terminal for the system.
 - f. Real-Time Clock: Controllers that perform scheduling shall have a real-time clock.
 - g. Serviceability:
 - 1) Controllers shall have diagnostic LEDs for power, communication, and processor.
 - 2) Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
 - 3) Each NAE and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
 - h. Memory:
 - 1) Controller memory shall support operating system, database, and programming requirements.
 - 2) Each NAE and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 - 3) Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
 - i. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
 - j. Transformer: ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.
2. Input and Output Interface
- a. General: Hard-wire input and output points to NAEs, AACs, ASCs, or SAs.
 - b. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point

contact with up to 24 V for any duration shall cause no controller damage.

- c. Binary Inputs: Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- d. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
- e. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- f. Binary Outputs: Binary outputs shall send a pulsed low-voltage signal for pulse width modulation control or an on-or-off signal for on and off control. All binary outputs on Building Controllers (NAE), Advanced Application Controllers (AAC), and Application Specific Controllers (ASC) shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- g. Analog Outputs: Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. All analog outputs on Building Controllers (NAE), Advanced Application Controllers (AAC), and Application Specific Controllers (ASC) shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- h. In-State Outputs: Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs) in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers. Provide manual override capability via hardware switch (drive open-neutral-drive closed) at the local Controller level for each tri-state output.
- i. Universal Inputs and Outputs. Controller inputs and outputs shall be universal. Input or output shall be designated binary or analog in software and shall be assigned appropriate properties. Non-universal inputs and outputs may be substituted for universal inputs and outputs provided control meets the requirements of paragraph 2.17 of this Section (Sequences of Operation).
- j. Power Supplies: Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and

secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

- 1) DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a) Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b) Line voltage units shall be UL recognized and CSA listed.

- k. Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - 1) Dielectric strength of 1000 V minimum
 - 2) Response time of 10 nanoseconds or less
 - 3) Transverse mode noise attenuation of 65 dB or greater
 - 4) Common mode noise attenuation of 150 dB or greater at 40-100 Hz

3. Automatic Control Valves
 - a. Control valves shall be two-way pattern as shown, constructed for tight shut off and shall operate satisfactorily against system pressures and differentials. Two-way control valves shall exhibit equal percentage characteristics. Valves with size up to and including 2 inch shall be screwed with 250 psi ANSI pressure body rating; 2½ inch and larger valves shall be flanged configuration. Proportional control valves shall be sized for a maximum pressure drop of 4.0 psig at rated flow (except as noted). Two-position control valves shall be line size and shall be provided with a 250 psi static pressure body rating.

 - b. All valves shall be capable of operating in sequence when required by the sequence of operation. All control valves shall be sized by the control manufacturer and shall be guaranteed to meet heating and cooling loads specified.

 - c. All control valves shall be suitable for the pressure conditions and shall close against the differential pressure involved. Valve operator connection type (screwed or flanged) shall conform to pipe schedule in this specification.

- d. Valves shall be sized on the exact pressure drop for the equipment served to prevent over or under sizing the valves. Provide a separate submittal with all of this information included.
4. Valve Actuators (Electronic):
 - a. Actuators shall be of the gear train or hydraulic type.
 - b. Actuators shall have integral mechanical stroke limiting adjustments to prevent actuator overstroke and automatic load sensing to protect from motor burnout in stall condition.
 - c. All actuators shall be sized by the ATC contractor and guaranteed to provide torque and stroke characteristics for the applied duty. Output shall be compatible with outputs of the controlling device. All actuators shall be of the spring return type, linked normally open or closed as applicable and common to the application.
 - d. All actuators shall be of the direct analog fully proportioning variety. Two position or floating type control actuators may be used only if specifically mentioned in the sequence of operation.
5. Temperature Sensors: Temperature sensors shall be RTDs or thermistors. Sensor Time Constant shall not exceed 5 seconds for a 60% response to a step change in temperature. Sensor repeatability shall be 0.1°F or better.
 - a. Space temperature sensor element shall be accurate within +0.5°F over a range from 40°F to 100°F. Sensors shall be housed in manufacturer standard miniature type thermostat cover and shall include exposed thermometer, setpoint adjustment and override button as specifically called for in the sequence of operation.
 - b. Outside air temperature sensor elements for each of the controllers shall be accurate within +0.5°F over a range from -20°F to 120°F.
 - c. Duct sensors shall be of the averaging type. Element length shall be adequate for sensing the average cross-sectional temperature over the full duct cross-section.
6. Pressure Switches: The pressure switches shall meet but not be limited to the following specifications:
 - a. Sensing elements shall be capsule, diaphragm, bellow, bourdon tube, or solid state capable of withstanding 150% of rated pressure (sensor).
 - b. Switch actuation shall be adjustable for the specified application.
 - c. Switch shall have snap-action Form C contact rated for the application.
 - d. Gauge pressure switches shall have adjustable differential settings.
 - e. Accuracy of +1% of the switch setting.

- f. Flow Switches: Flow switches shall meet but not be limited to the following specifications:
 - 1) Repetitive accuracy of +1% of operating range.
 - 2) Switch actuation adjustable over the operating flow range.
- 7. Miscellaneous Control Panels: Details of each panel shall be submitted for review prior to fabrication. Locations of each panel shall be convenient for adjustment and service. Provide engraved nameplate beneath each panel mounted control device clearly describing the function of said device and range of operation. All manual switches shall be flush mounted on the hinged door.
- 8. All electrical devices within the panels shall be factory pre-wired to a numbered terminal strip. All wiring within the panel shall be in accordance with NEMA and UL Standards and shall meet all Local Codes. All wiring in occupied spaces shall be concealed whenever possible. Any exposed wiring shall be enclosed in painted wiremold, color as selected by the owner's representative.

2.19 ATC SEQUENCE OF OPERATION

A. Boiler:

- 1. The boiler shall be monitored and controlled through the existing building EMS and shall be capable of start, stop and status functions.
- 2. When the outside air temperature is below 65 °F, the lead boiler shall be energized. Existing space sensors/thermostats within the building, as shown on the contract drawings, shall call the boiler to produce steam. The EMS shall call the boilers to provide heat to the building through either the average of sensor setpoints, 55°F (adjustable) in unoccupied mode or 68 °F (adjustable) in the occupied mode, or to maintain the lowest sensor setpoint, 55 °F (adjustable) in unoccupied mode or 68°F (adjustable) in the occupied mode, as selected by the building staff within the dynamic graphic. Upon a call for heat from the EMS, the lead boiler shall be energized through the combustion air damper end switch and shall operate through its control system to maintain steam pressure in the steam header (header pressure controls to be provided as part of this contract). Provide lead/lag boiler controls.
- 3. Upon either a fuesomatic switch sensing flame or the boiler emergency shutoff switch being placed in the OFF position, the boiler shall be deenergized and the appropriate alarm signal shall be transmitted to the EMS.
- 4. The boiler burner control panel shall transmit alarm signals from the boiler control panel to the EMS; the EMS shall transmit alarms to points (cell phones, text messages, security, etc.) designated by the Owner.
- 5. The steam header shall be provided with a steam pressure sensor and shall transmit alarms to the EMS; the EMS shall transmit alarms to points (cell phones, text messages, security, etc.) designated by the Owner.

6. **Combustion Air:** Whenever the boilers are called to operate by the manufacturers control system the combustion air damper shall open, the supply air fan shall energize and via end switches wired in series the boilers shall start.
7. **Boiler Feed Unit:** Whenever the boiler pump controller calls feed water, the feed water pump shall be energized and operate to maintain the respective boiler water level controller through the boiler feed unit packaged controls.
8. **Make-up water:** When the boiler packaged controls sense a low water condition, the controller shall call for make-up water. The make-up water control valve for the respective boiler shall modulate open to maintain the respective boiler water level. The blow down separator shall be provided with make-up water through a capillary tube sensor on the discharge/drain piping.
9. **Blow-down:** Automatic blow-off valves with timers shall be utilized to provide boiler blow-down cycle on a regular basis, with the times being staggered to prevent both boilers from opening the valves simultaneously. The blow down separator shall be provided with make-up water as needed with a modulating control valve operated to maintain maximum temperature set point in the discharge/drain piping.

6-13-14 2.20 **DRAFT CONTROL SYSTEM**

- A. **This system shall provide constant chimney pressures required by the heating appliance being vented. The following are components of the system:**
 1. **US Draft Co., Termination Draft Control System, ETL-listed to UL STD378 & UL STD 705.**
 2. **Electrical connections, by installing contractor.**
- B. **Furnish US Draft Co. Termination draft inducer(s) with design volume and design pressure as scheduled on the drawings and specified. The draft inducer shall be listed to UL STD 378 and UL STD 705 and shall bear the listed mark from an OSHA approved NRTL.**
 1. **The entire draft inducer shall be constructed of carbon steel and powder coated with a silicone based high temperature (1,000°F) coating. The draft inducer shall be constructed of minimum 16 ga. steel. The Draft inducer housing shall be continuously welded to insure liquid tight construction.**
 2. **The draft inducer impeller shall be statically and dynamically balanced with permanently attached balancing weights. Balancing weights shall be of the same material as the impeller.**
 3. **The draft inducer shall be listed for 575°F exhaust gas temperatures.**
 4. **The draft inducer motor shall be electronically commutated totally enclosed and outdoor rated. The motor shall have a minimum efficiency of 75%; permanent split capacitor motors shall not be approved.**

C. Performance

1. **The draft inducer system shall be able to reach set-point within 15s of initial call for heat.**
2. **The draft inducer system shall include an intelligent feed-back signal to determine the RPM of the motor.**
3. **The draft inducer shall maintain the draft set-point to within +/- 0.01" W.C.**
4. **The pressure control shall disable the appliances within the user determined time or 15s for oil appliances if the user determined pressure cannot be maintained.**

D. Sequence of operation

1. **A call for heat is received by the pressure control which activates the sensor check function when available. Once the sensor functionality has been verified, the system controls the fan speed to achieve the set point. Once the set-point has been achieved, the system energizes the safety relay of the appliance calling for heat**
2. **As individual appliances call for heat, the system will adjust the fan speed to maintain the set-point pressure. When all appliances have satisfied, the controller will disengage the draft inducer.**

E. Electrical requirements

1. **Power supply shall be:**
 - a. **VIC series pressure control: 120VAC, single phase, 60Hz**
 - b. **EC motors: 120VAC or 240 VAC, single phase, 60Hz**
 - c. **VFD: 240VAC, single phase, 60Hz, 208VAC or 480VAC, three phase, 60Hz**
 - d. **Damper Actuator, 24 VDC, 1 amp.**
2. **All wiring shall be in accordance with the National Electrical Code.**
 - a. **VIC series pressure controller**
 - b. **Draft Inducer**
 - c. **Supply Fan**
 - d. **Damper actuator**
 - e. **CGM-503 CO safety control**

- F. **All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 24 months from the date of delivery to the construction site. The warranty shall be provided by the equipment vendor and shall include the parts necessary to repair or replace all defective parts and materials.**
- G. **Installation and operation manuals shall be provided to the Owner's Representative, complete with product literature on the supply fan and controls, dimensional and wiring diagrams. Owner's Representative and designated personnel shall be instructed in the proper operation and maintenance of the packaged system.**

PART 3 - EXECUTION

3.01 GENERAL

- A. Install all items specified under PART 2 - PRODUCTS, according to the applicable manufacturer's recommendations and shop drawings, the details shown on the drawings and as specified under this section. Provide all required hangers and supports.
- B. All welding done under this section shall be performed by experienced welders in a neat and workmanlike manner. All welding done on piping, pressure vessels and structural steel under this section shall be performed only by persons who are currently qualified in accordance with ANSI Code B31.1 for Pressure Piping and certified by the American Welding Society, ASME or an approved independent testing laboratory; and each such welder shall present his certificate attesting his qualifications to the Engineer's representative whenever requested to do so on the job.
- C. All pipe welding shall be oxyacetylene or electric arc. High test welding rods suitable for the material to be welded shall be used throughout. All special fittings shall be carefully laid out and joints shall be accurately matched intersections. Care shall be exercised to prevent the occurrence of protruded weld metal into the pipe. All welds shall be of sound metal free from laps, cold shots, gas pockets, oxide inclusions and similar defects.
- D. All necessary precautions shall be taken to prevent fire or damage occurring as the result of welding operations.

3.02 PIPING

- A. Provide and erect in a workmanlike manner according to the best practices of the trade, all piping shown on the plans or required to complete the installation intended by these specifications.
- B. This Subcontractor shall inform himself from the Engineer's specifications and detailed drawings of the exact dimensions of finished work in all rooms where equipment or pipes are to be placed, and arrange his work accordingly, assuming all responsibility for conformity with the surrounding work.
- C. In the erection of mains, special care must be used in their support and proper allowance shall be made for expansion.

- D. All steel piping larger than 2" shall have welded joints made by experienced pipe welders. The joints shall all be well filled with metal without interior projections. After welds are made, this Subcontractor shall thoroughly clean inside and leave a smooth bore. Where connections are made on runs, weld-o-lets or thread-o-lets are to be used.
- E. All other connections are to be made with screwed fittings.
- F. In making welds, this Subcontractor is to have the end of the pipe properly beveled and perfectly lined up.
- G. Keep plugged or capped all openings in pipes or fittings.
- H. Connections to mains are to be provided with swing arms to provide for expansion.
- I. Make such offsets as are shown or required to place pipes on risers in proper position or to avoid other work. Make such offsets neatly and properly locate them to the satisfaction of the Engineer.
- J. All pipe lines are to be provided with sufficient number of flange fittings or unions to make possible the taking down of the pipes without breakage of fittings. Lines 2" in diameter and less may be connected by R & L couplings, unless otherwise required by the Engineer. All of the piping shall be erected so as to provide for the easy flow of water and noiseless circulation. Whenever pipes are cut, three wheel cutters are to be used and the pipes are to be carefully reamed out.
- K. Due to the extreme limited headroom, all water mains shall be installed perfectly level or with minimum pitch. Install air vents on all high points and drawoff valves on all low points throughout the entire system.
- L. The entire piping system shall be provided with shutoff valves and drawoff valves so that sections of the system may be drained without interrupting the entire system.
- M. Extreme care shall be exercised in the location of all piping.
- N. No crosses or bull head tees shall be used in any part of the work.
- O. Piping connections to all equipment shall be made with companion flanges or unions for ease in removal of equipment.
- P. Provide approved pipe identification markers and flow direction arrows on all piping. Markers to be at 30 foot intervals, except in boiler room where they shall be at 10 foot intervals.

3.03 VALVES

- A. Valves shall be installed where shown on plans and elsewhere as necessary for the proper operation or balancing of the systems.
- B. At completion, this Subcontractor shall install stamped brass tag on each valve held on with brass drain (except on fan-coil unit valves) with numbers. Make up schedule with number of each valve. Schedule to describe use of each valve. One copy of schedule to

be framed under glass and hung in boiler room. Two more copies are to be supplied to the Engineer.

3.04 STRAINERS

- A. Strainers shall be installed at all points shown on the plans. All strainers shall be cleaned prior to balancing, and again at completion of installation.

3.05 THERMOMETERS AND PRESSURE GAUGES

- A. Thermometers and pressure gauges shall be installed at all points shown on plans. Care shall be exercised to install gauges and thermometers in locations that can be easily read.

3.06 PIPE HANGERS

- A. Pipe hangers of the types specified shall be installed for the support of all piping. Maximum center-to-center hanger spacing shall be as follows, except as otherwise indicated on the Drawings:

Pipe Size	Max. Spacing
Up to 1-1/4"	5'-0"
1-1/2" and 2"	8'-0"
2-1/2" and 3"	8'-0"
Over 4"	10'-0"

3.07 SLEEVES

- A. Sleeves shall be installed for each pipe passing through masonry floors or walls.

3.08 ESCUTCHEON PLATES

- A. Escutcheon plates shall be installed on all piping passing through finished floors, walls or ceilings. Escutcheon plates shall be sized for outside diameter of insulation and installed after insulation is completed.

3.09 SPECIALTIES

- A. Specialties of the type specified shall be installed at points specified and elsewhere where shown on the drawings.
- B. Air vent valves shall be installed at every high point throughout the system.

3.10 INSULATION

- A. All of the insulation work shall be done by contractors regularly engaged in this type of work in a neat and workmanlike manner. All insulation shall be completely sealed with no glass fibers exposed to the air.
- B. All new piping system, including piping, valve bodies, fittings, specialties, air separator, pump casings, shot feeder, etc., shall be carefully insulated throughout for thermal control and to prevent condensation. Special care shall be exercised to ensure that all piping,

valve bodies and fittings are well insulated with vapor barrier at the fan-coil units, up to the final connection at the coil so as to prevent condensation from forming and dripping on the ceiling. All insulated equipment which requires servicing shall be insulated with removable sections.

3.11 EQUIPMENT

- A. Boilers and all other equipment shall be installed complete with all required hangers and supports in accordance with the manufacturer's recommendations.
- B. Furnish and install all steel structural support members for proper hanging and support of equipment. Provide vibration isolation on all hangers.

3.12 PLACING IN SERVICE

- A. At the completion of performance tests and following approval of test result, recheck all equipment to see that each item is adequately lubricated and functioning correctly.

3.13 VIBRATION ABSORPTION

- A. All equipment and piping shall operate without objectionable or unusual noise or vibration, as judged by the Engineer.
- B. Rotating equipment shall be fitted with such vibration-absorbing facilities as will be required to limit the transmission of vibration to the building and to the attached piping and breaching. The facilities shall be generally designed to limit this transmission to a maximum of 2%, but a greater amount will be allowed if it does not prove objectionable. The facilities shall also be designed to limit equipment floor loadings to 500 lb/sq. ft. or less. If, in order to accomplish this, the equipment requires the job installation of isolation mountings, inertia blocks, special hangers or other arrangements, these shall be carefully and specifically selected for each piece of equipment.
- C. Motor driven equipment shall have the motor, equipment and drive mounted on a common base. Hollow bed plates shall be grouted with a rich cement mortar.
- D. Submit shop drawing data for approval by the Engineer showing the make, type, and size of isolation mountings, flexible pipe connectors, and other facilities to be provided, including any concrete inertia blocks that may be required. The data shall clearly indicate that the isolating arrangements can and will limit the transmission of vibration as specified.

3.14 MISCELLANEOUS IRON AND STEEL

- A. Provide steel supports and hangers required to support fans, tanks, air handling units, pipe, ductwork, and other equipment or materials. Submit details of steel supports and method of fabrication for approval.
- B. All work shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets, and framework shall be properly sized and strongly constructed.

- C. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be by experienced metal working mechanics. Members shall be straight and true and accurately fitted. Scale, rust, and burrs shall be removed. Welded joints shall be ground smooth where exposed. Drilling, cutting and fitting shall be done as required to properly install the work and accommodate the work of other trades as directed by them.
- D. Members shall be generally welded, except that bolting may be used for field assembly where welding would be impractical. Welders shall be skilled.
- E. All shop-fabricated iron and steel work shall be cleaned and dried and given a shop coat of paint on all surfaces and in all openings and crevices.

3.15 TESTING

- A. All new piping systems, in whole or in part, prior to insulating and being closed in, shall be subject to a hydrostatic test pressure of 100 psig for eight hours without a pressure drop at the end of the test period. All leaks that occur shall be repaired by removing the joints in their entirety, rejoining, and test repeated as often as necessary until the piping system or systems are absolutely tight.
- B. Furnish all necessary equipment to conduct the testing of the piping system.
- C. Two pressure gauges shall be used whose range shall not exceed 0 to 150 psig, nor be less than 0 to 120 psig. Evidence of leakage or pressure drop shall be cause for rejection.
- D. A log of all tests shall be kept by the Contractor. The log shall provide a description of the test or inspection, the date performed, and the signatures of the responsible contractor's person performing the work and the witnessing engineer. This log shall form part of the final documentation. Failure to maintain this log will result in re-inspection or testing at the Contractor's expense.

3.16 BOILER/BURNER INSTALLATION

- A. Preliminary requirements: Provide the services of a Company Field Advisor of the Boiler manufacturer for the following:
 - 1. To assist and review the installing contractor with the assembly and erection of each Boiler. Upon completion of the Boiler assemblies, the Boiler manufacturers Company Field Advisor shall certify the proper assembly and connection of each Boiler prior to startup.
 - 2. The Boiler manufacturers Company Field Advisor shall be Present at time of Start-up to supervise the initial firing of the Boiler(s).
 - 3. The Boiler manufacturers Company Field Advisor shall instruct Boiler Room Operating Personnel.
- B. Provide beneath each of the new Boilers, a new poured and reinforced concrete foundation pad at least four inches higher than the surrounding floor (6 inches thick), and at least six inches wider than the Boiler on all sides. Provide four hold down bolts of at

least 5/8-inch diameter into the concrete and fastened through the base channels of the Boiler. The concrete for the foundation pad shall be a mixture of Portland cement, washed aggregate, and potable non-chlorinated water prepared and poured in compliance with Article 15 of the Massachusetts State Building Code and the American Concrete Institute Standard 318. Deliver to the Consulting Engineer certification by the concrete supplier that the mixture will attain a 28-day compressive strength of at least 4,000 pounds per square inch. Reinforce this concrete with Number 4 steel reinforcement bars arranged in a 12" by 12" mesh.

- C. Boiler drain valves shall be connected to the lowest water space available and shall be installed with pipe and fittings to connect the bottom blowoff full size to drain. Furnish and install 3" by 1-1/4" eccentric reducer in the lower left or right hand tappings of the front section of each Boiler complete with a short nipple and blowoff valve installed. Each blowoff valve shall be Brass, ball type, not less than 1-1/4" minimum and rated equal to the pressure stamped on the Boiler and to a temperature rating of not less than 250°F and all blowdown discharges shall be arranged so as to allow the Operator to view the water that is discharged to drain. Ends of blowdown piping shall be cut at a 45 degree angle to prevent a cap or plug from being installed.
- D. All Boiler discharges shall be piped to floor drains or as indicated by the Consulting Engineer. Furnish and install all necessary pipe and fittings to connect the side outlet safety valve discharge full size (Minimum Acceptable) to floor drain. Discharge shall be arranged so that there will be no danger of scalding Boiler room personnel in the event of a pressure relief situation. Size and arrangement of discharge piping shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the Safety valve below that required to protect each Boiler. All such discharge piping shall be supported by hangar or standoff to prevent the valve body from undue stress or strain.
- E. Furnish and install all necessary one inch IPS iron pipe, crosses, plugs, bushings, unions, vents and any other accessories as may be required to arrange the waterline control devices on the water column and the equalizing pipe as required by ASME, Section IV, Article 6 and recommended as good practice by the Boiler manufacturer. Float type devices shall each be vented at a high point, provide and install a vacuum breaker on each Boiler.
- F. The steam connection to the water column shall be taken from the top of the Boiler front section. Utilize cross fittings at each turn with the cleanout plugs installed. All float type waterline control devices shall be equipped with a one inch NPT vertical pipe with a blowdown valve installed and located at the lowest point in the water equalizing pipe connections so that the sediment chamber and the equalizing pipe of each device can be flushed and the Burner shutdown action of the control tested. Blowdown valves shall each be Brass, ball type and not less than one inch NPT and they shall be piped so as to discharge away from the Boiler and to a floor drain or as directed by the Consulting Engineer. Blowdown piping shall be cut at a 45 degree angle to prevent the installation of a cap or plug.
- G. The multiple steam pressure controls shall be mounted upon or fed from a manifold or they can be installed singly at separate tappings. If installed with a manifold, the control manifold and the common source connection to the Boiler shall be at least 3/4" inch IPS size. Each pressure control shall be protected with a siphon or equivalent means of maintaining a water seal that will prevent steam from entering the control. Steam

pressure gauge shall be installed complete with Inspectors' gauge cock and equipped with internal or external siphon.

- H. Provisions shall be made for the expansion and contraction of the steam mains connected to each Boiler by providing substantial anchorage at suitable points and by providing swing joints to allow the piping to expand and contract without imposing excessive forces on each Boiler. Steam stop valves shall be provided and located at an accessible location in the steam delivery line as near each Boiler outlet as is convenient and practicable which shall be of the outside-screw-and-yoke rising stem type.
- I. Furnish and install strain free assembly of pipe and fittings to connect the condensate return to each back section as recommended by the Boiler manufacturer and as indicated by the Consulting Engineer. Installing Contractor shall utilize capped tees at all turns in the return piping to the back section of the Boiler for cleaning of the return piping at or near each Boiler. Pre-fabricated return yoke piping with loose running threads and compound rubber gaskets shall not be considered acceptable to this installation. Pumped condensate return Feedwater, makeup water and/or water treatment shall be introduced into the Boiler water through the return piping only.
- J. For each boiler, a fuseomatic switch shall be provided for boiler burner within 7'-0" of burner and at ceiling if ceiling is 12'-0" or more above furnished floor or higher; and an emergency shutoff switch for remote burner shutdown outside every boiler room entry.
- K. After final assembly and connection, each Boiler shall be thoroughly cleaned internally following the manner described within the Boiler manufacturer's installation instructions, or by ASME Section VI, either method acceptable by the Engineer.
- L. The process of cleaning the Boiler(s) shall include the use of a boil-out compound of Caustic Soda and Tri-Sodium Phosphate at the rate of one (1) pound of each chemical per 50 Gallons of total water in the system being cleaned. This cleaning shall include Boiler Cleanout, Surface Blowoff, Blowdown and a wash as directed and detailed in referenced instructions.
- M. The process of cleaning the Boiler(s) shall be repeated as often as necessary and as directed by the Consulting Engineer to ensure that all mill scale, core sand, rust, dirt and debris, cutting oils and thread sealers or any other contaminants have sufficiently been eliminated from the Boiler(s) and to produce a condition of the Boiler water that is clean and finally considered acceptable to the Consulting Engineer.
- N. All field tests after the Boiler(s) have been installed and connected to the system shall be limited to not more than 15 PSI. Installing Contractor shall furnish all equipment, piping, labor, staging, fittings, valves, hoses and other materials and shall pay all required permits for Inspection as may be required to perform such tests as may be directed by these Contract Documents and as required by the Consulting Engineer and the State Boiler Inspector.
- O. An initial Hydrostatic pressure test of 15 PSI shall be conducted on each Boiler for a period of not less than 5 hours. Tests shall be of such duration as necessary and as directed by the Consulting Engineer to ensure that each Boiler has been installed and piped correctly with no leaks or other improper operating conditions.

- P. Installing Contractor shall contact and notify the State Boiler Inspector when the installation of the Boiler(s), Burner(s) and controls is substantially complete. Installing Contractor shall request an inspection of the Boiler to be conducted by the State Boiler Inspector and to have a Certificate of Inspection issued upon satisfactory inspection.
- Q. After receipt of certificate of Inspection, Installing Contractor shall furnish a suitable glass front frame in which to place said certificate. Frame, with Inspection certificate inserted therein, shall then be placed on or posted in a suitable location within the Boiler room in which the new Boiler has been installed.
- R. Installing Contractor shall maintain all apparatus in satisfactory operating condition. Perform periodic Burner tune-up and cleaning of the Boiler fireside surfaces when dirty, provide preventative maintenance, perform turndown tests, conduct tests for Flame Safeguard, Combustion Efficiency, Draft tests, Limit Control tests and Safety Valve tests, check the ignition system and adjust, repair or replace any as necessary while the heating system is under his ownership and control and until such time as the Owner accepts the equipment, issues the Final certificate of Payment and assumes the full obligation of Ownership.
- S. Installing Contractor shall note that any Follow-Up Service (Hereinafter specified) as may be absorbed by the authorized Service representative shall in no way absolve the Installing Contractor from any and all responsibility for the Care, Service and Preventative Maintenance for Materials furnished to this Contract, while the Heating System is under his Control, and until final acceptance by the Owner.
- T. Installing Contractor shall guarantee the entire installation for a period of One (1) Year from the date of Owner Acceptance and beneficial usage by the Owner and Date of Final Payment.

3.17 BOILER

- A. An authorized representative of the Boiler or Burner manufacturer shall perform the initial start-up, final adjusting and testing of the Burners and Controls in the presence of the Gas Inspector and the gas Company representative and the Owners Operating Personnel.
- B. The process of Start-Up and Commissioning shall include Purging of the Boiler; Burner Operation Tests, including CO sampling, Stack Temperature; CO₂ sampling; Tests for Venting; Ignition Tests; Pilot Turndown Tests; Manifold Pressure Tests; Instruction to the Owner and all other such procedures as may be directed by the Consulting Engineer.
- C. The final results of a Combustion Efficiency Test with all pertinent Combustion Data shall be logged onto a check sheet which shall be submitted to the Consulting Engineer to prove compliance with this section of the Specifications and for Record purposes.
- D. Combustion efficiency testing shall include no less than the following:
 - 1. Clock and adjust Burner input at the Meter to establish correct rate of fire and set each Burner to rated input at High Fire. Set Main Gas regulator and provide all adjustments to both Primary and Secondary Air as necessary to ensure proper flame shape at 100% input with no direct impingement upon heating surfaces and

with good quality combustion with not more than 0.04% CO in the flue gas analysis.

2. CO2 in the flue gas with recorded Gross and Net Stack Temperatures to establish stack loss value. Each Burner shall be set to operate at the overall best performance and combustion efficiency for which the equipment is designed and capable of.
 3. Adjustment and checkout of all aquastat controls, limits, switches, operating controls, low water cutoff devices, gas valves, pressure regulators, combustion controls, high and low gas pressure switches and all Lockout conditions.
 4. He shall supervise purging of the Boiler(s) and shall conduct Pilot turndown tests. All required tests for proper venting which shall include setting and adjusting the Boiler outlet damper to the Boiler manufacturer's specifications.
 5. Provide instruction to the Owners Operating Personnel in the procedures to resolve a "Lockout" condition. Operating personnel shall also be instructed in the Operation and routine daily maintenance of the Burner and controls during the lightoff process. The Owner shall arrange to have the personnel who require training to be present at the Lightoff.
- E. Factory Authorized Service representative shall provide the initial Burner lightoff and One (1) Year of Follow-Up Burner service. This requirement shall not be waived, nor shall the responsibility for the Service Contract be assumed by any other party unless previously approved by the Consulting Engineer in writing.
- F. Authorized manufacturers service representative shall furnish One (1) Year of Follow-Up Burner Service on the Burner(s) and Control(s) which shall commence from the Date of Original Lightoff and shall continue Follow-Up Burner Service coverage up to and including the First Anniversary of Burner Lightoff.
- G. Follow-Up burner service shall include labor and materials to replace any parts or controls which might fail in service as the result of a defect in materials or manufacture. Normal wear and tear on parts as the result of daily operation will not be included as "no charge" items (nozzles, igniters, etc.) and other such devices, which may require replacement as the result of operation during the Follow-Up Service Contract shall not be included. Preventative maintenance, in the form of yearly tune-up and bi-yearly cleanings and adjustments shall be the responsibility of the Installing Contractor throughout the duration of the Follow-Up Contract while the equipment is under his control. Preventative maintenance, cleaning and routine adjustments shall not be performed by the Follow-Up service Contractor but by the Owners obligated Service Company.

END OF SECTION