

SECTION 23 09 00
AUTOMATIC TEMPERATURE CONTROL (ATC)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

General Provisions of Contract, including General and Supplementary conditions and General Requirements (if any) apply to work specified in this Section.

1.02 ALTERNATES

There are no alternates that apply to this section of the project.

1.03 DEFINITIONS

ATC Automatic Temperature Control
BMS Building Management System
EC Electrical Contractor (Division 26)
GC General Contractor
HC Heating (mechanical) Contractor
PC Plumbing Contractor
VAV Variable Air Volume
VFD Variable Frequency Drive

1.04 DESCRIPTION OF WORK

A. Work Included

1. ATC Work: All work relating to the controls work including DDC and non-DDC controls as specified below. Any references to graphics, Front End System, or operator functions such as scheduling, alarms, and dynamic real time editing of set points or overrides are also included in this bid.

The Front End work shall be based on using network controller(s) as necessary, locally at the building and provide all the details of the graphics, scheduling, and alarming associated with the Front End Work. The system shall be web-based.

Furnish all labor, materials, equipment, and transportation and perform all operations required to install a complete Direct Digital temperature control system in accordance with these specifications and applicable drawings. The system shall be an open protocol LonWorks system using FTT-10 topology DDC controllers. System communications bus shall be run as a multi-drop trunk and shall include all repeaters and/or routers to accommodate the network. The network architecture shall be such that no channel or sub-network will exceed network traffic of 70% of their capacity.

2. All temperatures are expressed in degrees Fahrenheit.
3. ATC contractor and his sub-contractors shall be responsible for start-up of all equipment provided under this section.

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4. The control system shall be installed by either of the following
 - a. T.A.C.
Maine Controls
400 Presumpscot Street
Portland, Maine 04103
(207) 774-0220
 - b. Trident, Inc.
187 Gray Road
Cumberland Center, Maine 04021
(207) 829-4001
5. ATC Contractor must be capable of providing, installing and servicing the control system in its entirety. Sub contracting of ATC wiring is permissible but the ATC contractor shall be ultimately responsible and liable for proper installation as outlined in Divisions 23 and 26 of this specification. Listing of the control contractors in item 4 above does not exclude any of these contractors from meeting all aspects of the project documents including both the plans and the specifications as it pertains to their scope of work.
6. The control systems shall be provided and installed by trained control mechanics regularly employed in installation and calibration of ATC equipment by the manufacturer or manufacturer's franchised dealer of temperature control equipment.

NOTE: Control installation is not acceptable by wholesalers, contractors or by any firm whose principal business is not directly involved with the manufacture and installation of ATC systems.
7. Shop drawings of entire control system shall be submitted for approval before work is started.
8. Provide ATC technician to test the complete ATC systems sequences for specified cycles of operation with the Testing and Balancing Contractor.
9. ATC Contractor must, at the end of the warranty period, furnish the Owner with all access codes, provide administrative passwords to all system software components, and provide all software including license agreements for all aspects of the system, assigned to the ATC control systems. This includes but is not limited to application programming software, LNS network management software, Visio (the proper version necessary where required for any software), and the Front End software.

B. Related Work Described Elsewhere

1. Excavation and backfill
2. Cutting and patching

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3. Electrical conduit and wiring, except as noted below
 4. All finish work
- C. ATC Electrical Work
1. Provide and erect all temperature control devices as specified.
 2. Power supply to switches, fused switches, outlets, VFD's, motor starters, to line terminals of equipment, and all related wiring and fuses to properly connect and operate all electrical equipment specified shall be furnished and installed under Division 26, "ELECTRICAL". Division 26 shall not mount electrical equipment to indoor mechanical equipment without the consent of Division 23. Division 26 shall not drill wiring holes in equipment casings but shall make use of factory wiring knockouts when present. Coordinate all wiring between Mechanical and Electrical to provide a complete and operating system.
 3. VFD's shall be provided by this section where indicated on mechanical plans and/or in this section. Division 26 shall wire power to equipment through the VFD's (where provided).
 4. All wiring provided under this section shall be in accordance with the latest rules and regulations of the National Fire Underwriters, National Electric code, State of Maine Oil Burner Code, and Local Codes Division 26. Install all wiring under the supervision of the Division 26. Any wiring that is not installed according to these standards, and which does not match wiring installed by Division 26 in type, quality and appearance shall be corrected by Division 26 at the expense of this section.
 5. Automatic Temperature Control (ATC) Data and Actuation Wiring

Electric wiring shall be furnished and installed by ATC Contractor under supervision of Division 26. Any wiring that is not installed according to these standards, and which does not match wiring installed by Division 26 in type, quality and appearance shall be corrected by Division 26 at the expense of this section.

All control and power wiring to be plenum rated.
 - a. On the 5th floor all control wiring will be above the suspended ceiling or in the walls and will not need to be run in conduit.
 - b. On the 2nd, 3rd and 4th floors control wiring run above suspended ceiling or in the wall will not need to be run in conduit. **Control wiring in areas where there is no ceiling to be run in EMT conduit.**
 6. Fans
 - a. Division 26 to wire to unit mounted disconnect switch with overload protection provided with unit.
 - b. Fans shall operate as indicated on "FAN SCHEDULE", as indicated in "Automatic Temperature Control" section of this specification.

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- c. Division 26 to provide 120 volt power from exhaust fans to motor operated dampers associated with each fan (where indicated). Dampers and actuators to be provided by ATC Contractor.

7. Automatic Temperature Control (ATC) Panels

Division 26 shall provide a dedicated 120 volt, 15 amp circuit breaker for each ATC panel. Wiring from circuit breaker to temperature control panels will be provided and installed by Div. 26. Division 26 shall also provide a duplex convenience receptacle on a separate circuit within 6 feet of each panel.

1.05 SHOP DRAWINGS & SUBMITTALS

- A. Shop drawings shall include information on head end computer system and peripherals, each piece of hardware, description of operation and wiring diagrams associated with the ATC system and wiring diagrams. The system architecture shall be submitted exactly as it has been installed in the field. This includes all levels of the LonWorks network as well as the Ethernet portions of the system. Locations shall be indicated on the drawings as well.
- B. Corrections or comments made on the shop drawings do not relieve the contractor from compliance with requirements of the drawings and specifications. Shop drawing review is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades and performing his work in a safe and satisfactory manner.
- C. Should any materials or products be purchased and/or installed without prior review and comment the contractor shall be required to remove or replace those products and/or materials if directed by the Architect at his own expense. If the materials are not removed (or replaced) or if the project is delayed as a result the Architect reserves the right to order the withholding of payment until the situation is resolved in a manner satisfactory to the Architect.

1.06 GUARANTEE

This Contractor shall guarantee all materials and workmanship furnished by him or his sub-contractors to be free from all defects for a period of no less than one (1) year from date of final acceptance of completed system and shall make good, repair or replace any defective work which may develop within that time at his own expense and without expense to the Owner. Any additional costs required to extend manufacturer's guarantee and warranty for the period specified, shall be included in Contractor's base bid.

1.07 TRAINING

ATC Contractor shall instruct the Owner in the use of the control systems, including training in the use of all digital control software and provide a backup copy of the final software package to the Owner on CD. The training sessions shall be for each of the 3 types of systems (2 – four hour sessions for each, for a total of 6 sessions) including the Front end work, the ATC LonWorks network, and the Variable Flow Refrigerant system.

1.08 CHANGE ORDERS

- A. No change shall be made from the work, equipment, or materials under this section except as directed in writing by Architect or Engineer.
- B. All requests for change in contract scope shall be accompanied by price including a breakdown list of materials with unit and extended prices and labor hours with unit and extended price, plus markups that have been applied.

1.09 COORDINATION

- A. Contractor shall be responsible to coordinate his work with that of other trades to adjust to field conditions prior to commencing work. If a reasonable solution cannot be achieved without compromising the integrity of the intended design or would result in additional cost the Architect must be notified immediately prior to commencement of work. Failure to do so does not relieve the Contractor from providing and installing the systems to the satisfaction of the Architect at no additional cost.
- B. Contractor shall be responsible to review job conditions and identify conflicts and/or obstructions to ductwork and piping prior to fabrication. If conflicts and/or obstructions are noted the Architect must be notified immediately prior to commencement of work. The cost of any fabrication work performed without confirmation and notification of conflicts and/or obstructions shall be the responsibility of the contractor.
- C. The overall coordination and installation of the entire temperature control system will be the responsibility of the ATC contractor. This includes, but is not limited to:
 - 1. The supply and installation of the control wiring for the Mitsubishi Multi Variable Flow Refrigerant System.
 - a. If another manufacturer of the Variable Flow Refrigerant System is approved, that manufacturer will have to bear the additional costs (if any) of the control wiring installation.
 - b. Project specific control wiring diagrams showing wire sizes and specifications are available for use during the bidding process in both AutoCAD and PDF Format through the engineer (Kurt Magnusson 207-846-1441 kmmse@maine.rr.com).
 - c. The ATC contractor will be responsible to assign and coordinate HVAC component addresses (dip switches) on equipment..

2. The new DDC control system will need to be monitored and controlled by the new front end system. This includes but is not limited to:
 - a. Occupied and unoccupied scheduling
 - b. All outputs to the ATC system shall have the ability to be overridden from the graphics workstation or through a web-based browser. These outputs shall also be provided with a timer function so that the operator may select an override as well as selecting a timer function, or a forever function.

1.10 WORKPLACE SAFETY

ATC contractor shall be responsible for the safety of his workpeople.

1.11 INSTRUCTION AND ADJUSTMENT

Upon completion of the project, the Temperature Control Contractor shall:

- A. Adjust for use by Owner, all thermostats, controllers, valves, damper operators, and relays provided under this section.
- B. Furnish two (2) instruction manuals covering function and operation of control systems for use of the Owner's operating personnel. A competent technician shall be provided for instruction purposes (see par. 1.07, "TRAINING").
- C. Temperature Control Contractor shall be responsible for balancing return air, exhaust (relief) air and outdoor air dampers on air handling units in order to achieve proper mixed air temperatures.

1.12 HAZARDOUS MATERIALS

Mercury, or any other material deemed hazardous by the Federal Environmental Protection Agency or the State of Maine Department of Environmental Protection, shall not be used in any components of the ATC system.

PART 2 - PRODUCTS

2.01 VARIABLE FLOW REFRIGERANT (HEAT PUMP) SYSTEM

A, General Criteria

1. This section of the control specification (2.01) is based on the Mitsubishi CITY MULTI Variable Flow Refrigerant System. **Alternate approved manufacturers will be required to meet or exceed this specification. The alternate approved manufacturer will need to provide the engineering design, coordination and cost differential of installation to produce the specified performance.**
2. The manufacturer of the Variable Flow Refrigerant System shall provide Factory start-up of the Heat Pump equipment as well as Factory start-up and programming of the Heat Pump control system.
3. The manufacturer of the Variable Flow Refrigerant System shall provide the equipment and on-site support required to communicate with the Owner's Central Building Management System.
4. The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via LonWorks[®].

B. Electrical Characteristics

1. General:

The CMCN shall operate at 24VDC. Controller power and communications shall be via a common non-polar communications bus.

2 Wiring:

Control wiring shall be installed in a system daisy chain configuration from indoor unit to ME remote controller to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

Control wiring for schedule timers, system controllers, and centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to system controllers, to the power supply.

The G-50A and GB-50A system controller shall be capable of being networked with other G-50A and GB-50A system controllers for web based control.

3. Wiring type:

Wiring shall be 2-conductor (16 AWG or 18 AWG), twisted shielded pair, stranded wire, as defined by the Design Tool AutoCAD output.

Network wiring shall be CAT-5e with RJ-45 connection.

C. CITY MULTI Controls Network

The CITY MULTI Controls Network (CMCN) consists of remote controllers, system controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, online maintenance support, and integration with Building Management Systems (BMS) using a LonWorks[®] interface.

D. Air Handlers Remote Controllers

The remote controllers be Mitsubishi Simple Remote controllers Model PACY51CRB **Set dipswitch on all controllers with room temperature sensing at the controller location (not in the return air).**

E. Centralized Controller (two required)

G-50A Centralized Controller

The G-50A Centralized Controller shall be capable of controlling a maximum of 50 indoor units across multiple CITY MULTI outdoor units. The G-50A Centralized Controller shall be approximately 5"x12" in size and shall be powered from a Power Supply Unit (PAC-SC50KUA). The G-50A Centralized Controller shall support operation superseding that of the remote controllers, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. The G-50A Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic control set of operation controls for the G-50A Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2-Series only), dry, and fan), temperature setting, fan speed setting, and airflow direction setting. Since the G-50A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the G-50A Centralized Controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, and permit/prohibit of remote controllers.

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G-50A (Centralized Controller)			
Item	Description	Operation	Display
ON/OFF	Run and stop operation for a single group	Each Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is in the CITY MULTI R2-Series only.	Each Group or Collective	Each Group
Temperature Setting	Sets the temperature for a single group. Range of temperature setting: Cool/Dry: 67°F-87°F (57°F-87°F for PEFY/PDFY/PFFY-E) Heat: 63°F-83°F (63°F-83°F for PEFY/PDFY/PFFY-E) Auto: 67°F-83°F (63°F-83°F for PEFY/PDFY/PFFY-E) * Range of temperature setting varies depending on the model.	Each Group or Collective	Each Group
Fan Speed Setting	Models with 4 air flow speed settings: Hi/Mid-2/Mid-1/Low Models with 3 air flow speed settings: Hi/Mid/Low Models with 2 air flow speed settings: Hi/Low	Each Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction angles 100%-80%-60%-40%, Swing, *1. Louver cannot be set. Air flow direction settings vary depending on the model.	*1 Each Group or Collective	Each Group
Timer Operation	Start/Stop and Enable/Disable can be set 3 times in one day. For a week's schedule, store three start/stop patterns and one enable/disable pattern. *2 When the timer is set, "Timer Enabled" is shown on the operation setting screen of the LCD.	Each Group or Collective	*2 Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *3: Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Group or Collective	*3 Each Group
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed *4 When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective

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G-50A (Centralized Controller)			
Item	Description	Operation	Display
Test Run	Operates air conditioner units in test run mode.	Each Group	Each Group
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between “Hi”, “Low” and “Stop”. When setting a group of only free plan LOSSNAY units, you can switch between “Normal ventilation”, “Interchange ventilation” and “Automatic ventilation”.	Each Group	Each Group
External Input / Output	By using accessory cables you can set and monitor the following. Input By level: “Batch start/stop”, “Batch emergency stop” By pulse: “batch start/stop”, “Enable/disable remote controller” Output: “start/stop”, “error/Normal” *5: Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective

All G-50A Centralized Controllers shall be equipped with one RJ-45 Ethernet port to support interconnection with a network PC via a closed/direct Local Area Network (LAN).

The G-50A Centralized Controller shall be capable of performing initial settings via the keypad and display on the controller or via a PC using the G-50A Centralized Controller’s initial setting browser.

Optional software functions shall be provided so that the building manager can securely log into each G-50A via the PC’s web browser to support operation monitoring, scheduling, error email, personal browser for PCs and MACs, and online maintenance diagnostics.

F. CMCN: System Integration

The CMCN shall support the integration with Building Management Systems (BMS) via their LonWorks® using FTT-10 topology bus. See details below for all SNVT’s. ATC contractor shall map all variables into the network using an LNS network Management tool. These points shall be displayed on the graphics. The system shall be capable of adjusting fan speed, occupied/unoccupied modes with separate set points for each (set points shall be adjustable from the graphics), on/off control, and alarm status logging.

ATC contractor shall also provide alarm logging and high/low alarm set points for space conditions via the unit space temperature sensor. High/low alarm set points shall track the temperature set points so that a change in temperature set point shall not cause any nuisance alarm reporting. These set points for alarms and the differential from the space set points shall be displayed and adjustable at the graphics front end.

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LMAP03U: LonWorks® Interface

The Mitsubishi Electric HVAC LonWorks® interface, LMAP03U, shall support all units as shown on the drawings and in the schedules with a variety of network variables on a per indoor unit basis. Input variables include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, and filter sign reset. Output variables include, but are not limited to, model size, alarm state, error code, and error address.

All interface equipment necessary to provide a complete integration for all units as described above shall be provided by the unit manufacturer.

The unit manufacturer shall coordinate all integration with the ATC contractor and shall provide a qualified representative to perform start-up and testing of all integrations points. This includes all set up, node addressing, and binding to the Lon FTT-10 network as part of the ATC system.

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Item		nv No.	Description
Operation	Request All Off	nv1	Stops the operation of all air conditioners. The ON/OFF operation is invalid during emergency stop.
	Request On/Off	nv1n	Run and stop operation.
	Request Mode	nv3n	Sets the operation mode.
	Setpoint	nv5n	Sets the temperature.
	Request LOSSNAY Mode	nv7n	Sets the LOSSNAY operation mode.
	Request FanSpeed	nv9n	Sets the fan speed.
	Request Local Prohibit On/Off	nv11n	Sets the local remote controller to operation prohibit (On/Off).
	Request Local Prohibit Mode	nv13n	Sets the local remote controller to operation prohibit (operation mode).
	Request Local Prohibit SetPoint	nv15n	Sets the local remote controller to operation prohibit (temperature setting).
	Request Collective Local Prohibit	nv4	Sets the local remote controllers of all air conditioners to operation prohibit (On/Off, operation mode, temperature setting).
	Request Forced Thermostat OFF	nv17n	Forcibly turns the air conditioner thermostat OFF.
	Filter Sign Reset	nv19n	The run time (for filter) of air conditioner is reset.
	Time Stamp	nv12	Sets the local remote controller time.
	Request Limit Temperature Setting Range	nv13	Sets the temperature setting range of local remote controller.
	Request Simplified Locking	nv14	Sets the local remote controller switch's simple lock, and displays the mode and intake temperature.
Monitor	Emergency state	nv3	Output the emergency stop state.
	On/Off state	nv2n	Outputs the On/Off state.
	Collective On/Off state	nv2	Outputs the On/Off state for all air conditioners.
	Mode state	nv4n	Outputs the operation mode setting state.
	Setpoint State	nv6n	Outputs the temperature setting state.
	LOSSNAY Mode State	nv8n	Outputs the LOSSNAY operation mode setting state.
	FanSpeed state	nv10n	Outputs the fan speed setting state.
	Local Prohibit On/Off State	n12n	Outputs the local remote controller operation prohibit (On/Off) state.
	Local Prohibit Mode State	nv14n	Outputs the local remote controller operation prohibit (operation mode) state.
	Local Prohibit SetPoint State	nv16n	Outputs the local remote controller operation prohibit (temperature setting) state.
	Collective Local Prohibit State	nv5	Outputs the local remote controller collective operation prohibit state.
	Forced Thermostat OFF State	nv18n	Outputs the forced thermostat OFF state.
	Run Time for Filter	nv20n	Outputs the run time (for filter) of air conditioner.
	Space Temperature State	nv21n	Outputs the intake temperature of air conditioner.
	Defrost State	nv9	Outputs the defrosting state of indoor unit or outdoor unit.
	Group Number	nv29n	Outputs the group number of the indoor unit.
	Alarm State	nv22n	Outputs the presence of air conditioner errors.
	Collective Alarm for Indoor Unit	nv6	Outputs the presence of errors in all air conditioners.
	Collective Alarm for LM ADAPTER	nv7	Outputs the presence of communication errors between the LM ADAPTER and air conditioner.
	Error Code	nv23n	Outputs the presence of air conditioner errors content (error code).
	Error Address	nv24n	Outputs the error source (M-NET address) when an air conditioner error occurs
	Thermo On/Off state_1 (*1)	nv25n	Outputs the air conditioner operation, thermostat and auxiliary heater states.
	Thermo On/Off state_2 (*1)	nv26n	Outputs the thermostat state.
Model Code (*1)	nv28n	Outputs the air conditioner model code.	

G. Power Supply (PAC-SC50KUA-F)

The power supply shall supply 12VDC (TB 3) for the G-50 centralized controller and 24VDC (TB 2) voltage for the central control transmission.

H. Interconnection to Hot Water Valves in rooms with hot water baseboard heat

Where zone valves in rooms with hot water baseboard are shown on plans provide a PAC-YU24HT Adapter Cable (DC12v) to energize Hot Water Valve operation .

I. Additional Software

Provide the "Maintenance Tool" software or equivalent. In addition, provide a portable laptop computer or hand held device loaded with all software for all aspects of the system. Functions of the software shall include but not be limited to upload/download of all application controllers in the network, edit, add, delete, or replace controllers and applications. All necessary cabling to interface with all controllers shall also be provided by the unit manufacturer.

2.02 CONTROL PANELS

Provide and install surface mounted control panel(s) with dust tight gasketed, hinged door with enamel finish where indicated. All switches, relays and equipment necessary for system operation shall be provided in control panel.

2.03 ROOM CONTROLLERS

A. ATC contractor shall install the Mitsubishi room controllers.

B. The drawings indicate controller location and the associated Heat Pump Air Handler with and interconnecting dotted line. The interconnecting dotted line is not intended to represent the actual wiring.

C. All thermostats and room controllers shall be mounted according to current ADA requirements but not higher than 48 inches above finish floor to center.

2.04 LOW TEMPERATURE SAFETY THERMOSTAT

Electric/electronic low temperature warning thermostats shall have 20 ft. low point sensitive elements (not averaging type) installed to cover the entire duct area. These thermostats shall be two position manual reset type. Freeze-Stats shall be provided and wired to shut down the supply fan. Freeze stats shall also have an additional set of contacts provided for the BMS system to be wired as an alarm input. Status and alarm reporting shall be provided on the network for logging and display on the front end graphics

2.05 AUTOMATIC CONTROL VALVES

A. Automatic control valves for Cabinet Unit Heaters shall be two position, line size.

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B. Automatic control valves for duct heating coils shall be fully proportioning with modulating plug or V-port inner guides, unless otherwise specified. The valves shall be quiet in operation and fail safe in either normally open or normally closed position in the event of control air failure. 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 guaranteed to meet the heating and cooling loads as specified. All control valves shall be suitable for the pressure conditions and shall close against the differential pressure involved. Valve operators shall be of the molded synthetic rubber diaphragm type. Body pressure rating and connection type (screwed or flanged) shall conform to pipe schedule in this specification.

c. Interconnection to Hot Water Valves on duct heating coils

Where hot water coils are shown on plans provide a PAC-YU24HT Adapter Cable (DC12v) to energize Hot Water Valve operation or close a communication contact.

2.06 DAMPERS

A. Control dampers shall have 16 gauge galvanized frames not less than 2 inches in width with airfoil blades not less than 14 gauge galvanized steel, and shall be adequately braced to form a rigid assembly. No dampers shall have blades more than 6 inches wide. Dampers shall be painted with one coat of lacquer. Dampers shall be two position or proportioning as required by specific application, opposed blade type with linkage concealed within the frame. Oilite bronze bearings shall be provided at the ends of damper blades. ALL DAMPERS SHALL BE MOUNTED WITH BLADES ORIENTED HORIZONTALLY.

B. Damper operators shall be provided with bracket arrangement for location outside of air stream wherever possible. All damper motors shall be sufficient size to operate dampers, including slow opening and fast closing.

C. Dampers shall be provided with flexible metal edge and jamb seals and neoprene blade edge seals for tight closure. Leakage shall be certified to be no more than 2.0 CFM per square foot at 1 inch w.g. on units 24 inches wide and larger, 3.0 CFM per square foot at 1 inch w.g. on units less than 24 inches wide.

D. Control dampers furnished by the ATC Contractor shall include motor operated dampers installed in classroom air reliefs, exhaust fans, gymnasium air relief and air handling unit air intake and relief ducts.

E. Dampers shall be Ruskin Model CD60, Air Balance, Arrow, or approved equal.

2.07 VARIABLE FREQUENCY DRIVES

Provide variable frequency drives for Exhaust Air Fan and Outside Air fan for HRU-1. The VFD's shall have a LonWorks®. Communications module to provide the VFD information for display and monitoring on the Graphic screen. VFD's shall be sized appropriately for the motor horsepower connected including a 1.15 service factor. VFD's shall be controlled by the BMS for on/off control as well as speed control to maintain (supply duct pressure). Points shall be displayed on the graphics for on/off commands, speed status as well as override, differential pressure, set point adjust, and drive fault conditions.

2.08 HEAD END DDC COMPUTER

All scheduling, dynamic graphics, and high/low alarms, overrides, etc. as detailed throughout this specification for all DDC points and systems will be provided at the front end.

All testing and verification of this project shall be included. This shall include but not be limited to changing the system from occupied to unoccupied from the front end, and verifying the results at the building. Overrides and set point adjustments shall also be tested.

A print out of screen captures shall be provided for approval by the owner before populating the graphics with dynamic real-time data points.

Provide administrative level passwords for the owner (minimum of 4) and also include the AX Supervisor (part number S-AX) software licensed to the owner as part of this price. Owner shall provide a PC and location of the PC with static IP address(es) as necessary to operate the network software properly.

Building Architecture

The building shall consist of an FTT-10 LonWorks network using the LonTalk Protocol ANSI/EIA709.1 standard. The architecture shall include one or more Jace AX5 series as necessary to support the throughput of information to and from the remote Front End.

ATC contractor will provide and install the software for owner supplied PC(s)

2.09 Flow Metering Station

- A. ATC Contractor shall provide and install a flow metering station in the main return piping from the lobby area on the 1st floor that serves the Hot Water Duct Coil for Lobby 113.
- B. Units shall be designed to thread into a weld-o-let pipe tap.
- C. Units shall include brass flow meters and all required mounting hardware. Maximum working pressure shall be 200 psig at a maximum temperature of 221°F.
- D. Units shall also include a BTU monitor with USB, modbus or BACnet/MSTP capability to match the requirements of the BMS system. BMS system shall monitor and record BTU usage for the Café and main heating loops for Owner to accurately determine how much heat is being used for each zone. connector. A two-line by 16 character backlit LCD display shall be configurable by the Owner to display flow rate and flow total, plus energy and temperature measurements. Unit shall be capable of receiving inputs from not less than two remote sensors.
- E. Unit shall be Kele Model 220B sensor, Model UFT-1 flow transmitters and Model 3050 BTU Monitor or approved equal. Mount BTU Monitor in front door of ATC control panel.

PART 3 – EXECUTION (SEQUENCE OF OPERATION)

3.01 GENERAL

- A. Heating system shall be hot water with water supplied from the boiler and/or heat exchanger at a maximum of 180°F, with 20°F drop through the heating system in combination with Variable Flow Refrigerant System.
- B. Ventilation and cooling system shall be a Variable Flow Refrigerant System and an air-to-air heat recovery air handler.

3.02 RESET WATER CONTROL

A control sequence and hardware to maintain the water temperature to the system by modulating (resetting) boiler output temperature shall be provided within each boiler's own controls. ATC Contractor shall adjust the reset schedule to provide 130°F water @ 20°F outdoors to 90°F water @ 65°F outdoors (and higher). As the outside temperature falls, the supply water temperature shall be increased. On a rise in outdoor air temperature, the temperature of the water shall be decreased.

Supply water temperature to the heating system shall be maintained by modulating each boiler output via reset water schedules programmed at the boilers. Additional control shall be provided (at each boiler) to give priority to domestic hot water. Whenever pump P-5 activates, the reset water controller shall increase boiler output temperature to 180°F water for as long as required.

Coordinate with boiler manufacturer's literature for required control components and sequences not provided with boilers.

3.03 BOILER CONTROL

- A. Under normal conditions the boilers shall remain de-energized. When outdoor temperature drops to 30°F. (Adjustable through BMS) the boilers shall be energized and will cycle in response to internal controls to maintain an internal temperature maintained by reset water control.
- B. Boiler internal controls shall include:
 - 1. A true run time lead-lag control is specified to be supplied with the boiler controls. ATC Contractor shall provide and install communication wiring between boilers and with the ATC system.
 - 2. Coordinate with boiler manufacturer for required control components (if any) and sequences not provided with boilers.
 - 3. Boiler manufacturer is required to provide qualified personnel to install boiler related controls and wiring requiring field installation. Installer is required to work closely with the ATC Contractor and Commissioning Agent to be sure interlocks between boiler controls and building controls are installed and functioning properly. See section 23 00 00, par. 2.10, "BOILERS".
- C. Provide alarm points to send an alarm if either boiler goes into flame failure.

D. Control points to be used for monitoring and control:

1. Outside air temperature
2. Hot water supply and return temperature
3. Boiler 1 & 2 status (flame failure alarm).
4. Pumps 1 & 2 status (alarm)

3.04 CONTROL OF CIRCULATING PUMPS 1 & 2

- A. The pumps operate from internal controls. ATC contractor shall provide and install communication wiring between pumps and BMS to monitor to pumps or to de-energize them. Pump internal controls shall include internal lead/lag sequence and outdoor air control. Set lead/lag controls to rotate monthly. Should a pump fail the other pump shall be energized. Lead/Lag rotation functions shall be displayed and adjustable from the graphics. This includes duration, changeover time, and status. Alarm shall be generated at the graphics whenever a failure occurs.
- B. Pressure sensors in the pumps shall modulate pump speed in response to system pressure. As zone valves in the system close, the pumps shall reduce speed.
- C. Selected pump shall operate continuously when outdoor temperature is 30°F. (Adjustable through BMS) and lower.
- D. See section 23 00 00, par. 2.09, "PUMPS" for additional information.

3.05 OCCUPIED-UNOCCUPIED CONTROL

Occupied-Unoccupied control shall be a function of the DDC software in the BMS. Provide scheduling from front end graphics with full 365 day calendar functions and holiday scheduling. Coordinate with owner's personnel for all holidays prior to final acceptance. Front end graphics shall provide separate schedules for each piece of equipment accessible from the respective system graphics with the option of selecting an individual schedule for that system, or the master schedule for the building. Occupied/unoccupied network variables shall be sent to the respective controller on the Lon network.

3.07 DUCT HEATING COILS

- A. The control valves will be energized by a 12VDC signal from the Heat Pump Controls System. This signal will be a result of a second stage heat call.
- B. The valves will be modulating. A discharge air thermostat for all air handlers (equipped with hot water coils) will control discharge air temperature at 95 deg. F (adjustable).

3.08 AIR HANDLING UNITS

A. General

The heating and cooling control shall be as detailed in the Heat Pump Air Handling and Associated Duct Heating Coil Section.

- B. Occupied:
 - 1. The fans will be operated at high speed.
- C. Unoccupied:

The fans will be operated at low speed.
- D. Control points to be provided and shown at the BMS are as follows:
 - 1. Heat Pump points as detailed in Variable Flow Refrigerant System Control Sequence.
 - 2. Heating valve position and discharge temperature

3.09 HEAT RECOVERY UNITS

- A. Heat recovery unit shall operate from its own internal controls. Unit will be provided with a factory control panel. Mount adjacent to the ATC panel. ATC contractor shall be responsible to mount panels and provide ATC wiring
- B. Occupied:
 - 1. Heat Recovery units to be enabled by BMS.
 - 2. Zone valve on associated hot water coil to be modulated to maintain 70 deg. F discharge temperature (adjustable).
- C. Unoccupied:

Heat Recovery unit to be disabled by BMS
- D. Control points to be provided and shown at the BMS include:
 - 1. Enable and Disable
 - 2. Discharge Temperature
- E. Heat Recovery Unit (HRU-1) shall have a Variable Volume Damper on each of the conference room's return. The dampers will be controlled to maintain a maximum CO2 level of 800 PPM (adjustable) in each conference room. Control the volume of the exhaust air and outside air by outside air (supply air) duct pressure.

3.10 UNIT HEATERS AND CABINET UNIT HEATERS (NON-DDC)

Horizontal and cabinet unit heaters to be controlled by heavy duty line voltage remote thermostats and strap-on aquastat by ATC Contractor. When thermostat calls for heat unit fan will be energized providing supply water temperature is at least 130°F.

3.12 FANS (SERVING BOILER AND ELECTRICAL ROOMS)

- A. Exhaust fans to be controlled by DDC system

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B. Exhaust fans will run on a call for cooling.

3.13 LOW TEMPERATURE/FLOW AND BOILER FAILURE ALARMS

- A. Provide an immersion aquastat (normally open) with separable well in the heating hot water supply main between the boilers and reset water control valve. Also, provide a flow switch in the hot water supply line from pumps P-1 and P-2. The aquastat shall close an alarm circuit should the water temperature from the boilers drop below its temperature setpoint (110°F. - adjustable). The flow switch will also close this alarm circuit should the circulating pumps fail.
- B. Provide failure of burner ignition for new boiler.
- C. DDC software shall indicate an alarm condition upon failure of any burner, pump or low temperature.
- D. Aquastat and flow switch shall be de-activated when outdoor air temperature is above 60°F.

END OF SECTION 23 09 00