SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

This Section includes sequence of operation for most common mechanical systems and system components. Sequences apply or can be adapted to most types or configurations of automatic control systems.

Manufacturers found in SpecAgent for this Section were identified as representative and not as an endorsement for meeting the requirements of this specification.

This Section includes performance, proprietary, and descriptive type specifications. Edit to avoid conflicting requirements.

This Section includes the term Architect/Engineer. "Architect" is used in AIA contract documents; "Engineer" is used in EJCDC contract documents. Retain appropriate term.

See the Drawing Coordination Considerations for information needed to coordinate this specification Section with the Drawings.

1. GENERAL
   * + 1. SUMMARY
          1. Section includes sequence of operation for:

Cabinet Heaters.

Central refrigeration systems.

Central fan systems.

Combustion air unit heaters.

Exhaust fans.

Emergency generator with automatic dampers.

Excess pressure controls.

Fan coil units.

Heating Coils.

Heating water zone control.

Humidifiers.

Induction units.

Parking garage ventilation systems.

Radiant panels.

Radiation [**and convectors**].

Refrigeration systems.

Air terminal units.

Unit heaters.

* + - * 1. Related Sections:

Section 230900 - Instrumentation and Control for HVAC: For equipment, devices, and system components to implement sequences of operation.

Section 230923 - Direct-Digital Control System for HVAC: For equipment, devices, system components, and software to implement sequences of operation.

Section 230953 - Pneumatic and Electric Control System for HVAC: For equipment, devices, and system components to implement sequences of operation.

Section 255000 - Integrated Automation Facility Controls: For equipment, devices, system components, and software to implement sequences of operation.

* + - 1. SUBMITTALS

Only request submittals needed to verify compliance with Project requirements.

* + - * 1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
        2. Manufacturer’s installation instructions shall be provided along with product data.
        3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
        4. Section 013300 - Submittal Procedures: Submittal procedures.
        5. Shop Drawings: Indicate mechanical system controlled and control system components.

Label with settings, adjustable range of control and limits. Submit written description of control sequence.

Submit flow diagrams for each control system, graphically depicting control logic.

Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

Coordinate submittals with information requested in Section [**230900**] [**230923**] [**230953**].

* + - 1. CLOSEOUT SUBMITTALS
         1. Closeout procedures.
         2. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1. PRODUCTS (NOT USED)
2. EXECUTION
   * + 1. CABINET HEATERS

Use the following sequence for steam or hydronic heating.

* + - * 1. Single temperature [**electric**] [**room**] [**pneumatic**] thermostat [**mounted in cabinet return air**] set at [**68 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature by cycling unit fan motor.

Strap-on thermostats may be provided on all units.

* + - * 1. Single temperature thermostat on return heating water line [**from floor mounted cabinet heaters**] de-energizes unit on temperatures below [**95 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**].

Use the following sequence for electric units. Integral thermostat may be used when available from manufacturer.

* + - * 1. Single temperature [**room**] thermostat [**mounted in cabinet return air**] set [**68 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature by cycling unit fan motor and electric heating elements. [**Integral thermostat continues fan operation until element temperature falls below [100 degrees F] [<\_\_\_\_\_\_\_\_> degrees F].**]
      1. CENTRAL REFRIGERATION SYSTEMS

The following sequence generally applies to standard chiller/cooling tower refrigeration systems. Select sequences carefully to meet Project requirements.

* + - * 1. Time Schedule: Start and stop condensing water pump.
        2. Condensing Water Pump: Allow start on proof of water in cooling tower sump and on outdoor temperature above [**50 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**]. [**Start on demand from ventilation system.**]
        3. Energize chilled water pump to start and allow cooling tower fans to start when condensing water pump started.

Chiller valve option may be included for multiple chiller arrangements.

* + - * 1. When chilled water pump starts, open chiller control valve. Modulate chiller control valve to maintain constant flow through chiller.
        2. When flow switches prove chilled water flow and condensing water flow, allow refrigeration machine to start.

Select or insert temperature. Use 55 degrees F for absorption and 75 degrees F for centrifugal machines. Reciprocating machines will vary according to manufacturer.

* + - * 1. Maintain minimum condenser water temperature of [**55 degrees F**] [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] by [**modulating tower bypass valve**] [**and**] [**cycling cooling tower fans**].

Electric heating devices may not be required in some locations and systems, and are usually not used in systems with remote sumps.

* + - * 1. Maintain temperature in cooling tower sump of 40 degrees F by [**modulating heater control valve**] [**cycling electric sump heaters**]. Outdoor thermostat set at [**35 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] [**opens valve to**] [**activates electric**] heat tracing.

Dump cycle may not be required in some locations and systems, and is normally not used for systems with remote sumps.

* + - * 1. Thermostat in cooling tower sump, set at [**35 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**], open drain lines, closes make-up valve, and deactivates sump heaters and piping electric heat tapes.
        2. Display:

Edit to include desired items.

System graphic.

Condensing water pump on/off indication.

Chilled water pump on/off switch.

Chiller on/off indication.

Condensing-water temperature - supply and return.

Chilled-water temperature - supply and return.

Chiller condensing-water control point adjustment.

Common chilled-water control point adjustment.

Low level cooling tower sump alarm.

Expansion tank low-level alarm.

Cooling tower fan on/off indication.

Cooling tower sump heater on/off indication.

Cooling tower dump indication.

Chilled water control point adjustment.

The following only apply to control systems with local control panels.

Condensing water pump on/off [**auto**] switch.

Chilled water pump on/off/auto switch.

Chiller on/off [**auto**] switch.

* + - 1. CENTRAL FAN SYSTEMS

The following sequences incorporate many standard components of central air systems and include many types of systems. Select carefully those sequences applying to Project or system. Repeat and re-edit for different systems.

* + - * 1. Time Schedule: Start and stop supply and return fans. Determine fan status [**through auxiliary contactors in motor starter**] [**by pressure differential switches**] [**by current sensing devices**]. When fan fails to start as commanded, signal alarm.
        2. Safety Devices:

Freeze Protection: Stop fans [**and close outside air dampers**] when temperature [**before supply fan**] [**downstream of preheat coil**] [**and in preheat coil return line**] is below 37 degrees F; signal alarm.

High Temperature Protection: Stop fans and close outside dampers when temperature in return air is above 300 degrees F; signal alarm.

Smoke Detector: Stop fans, close outside dampers, and close smoke dampers when smoke is detected; signal alarm.

* + - * 1. Preheat Coil:

When fan is not running, and outside air temperature is below 40 degrees F, [**fully**] [**partially**] open preheat coil valve to heating.

When fan is running, maintain constant [**mixed air**] [**supply air**] temperature of 55 degrees F by modulating preheat coil valve.

The following provides option for separate outside air damper. Include for 100 percent outside air make-up unit to prevent collapsing damper or ductwork.

* + - * 1. Outside Air Damper: When supply fan is running, open outside air damper [**to minimum position**]. [**Prevent supply fan starting until outside air damper is open and position is verified.**]

Code requires outside air quantity is measured and maintained at a constant rate in variable air volume systems.

* + - * 1. Outside Air Control for Variable Air Volume Systems: Outside air measuring and modulation device located in [**air handling unit mixing box outside air opening**] [**outside air ductwork**], through the DDC controller, maintains fixed minimum outside air quantity independent of system air flow.
        2. Humidifier: When supply fan is running, allow humidifier to operate.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Humidifier: When supply fan is running, [**and there is water in humidifier sump**], humidistat located in return air, reset from outdoors [**modulates normally closed humidifier valve**] [**cycle spray pumps**] [**and modulates valve on spray header**]. Set outdoor reset to 50 percent relative humidity at 70 degrees F and 15 percent relative humidity at -30 degrees F.

Select mixed air control from the following paragraphs. Revise paragraph 5 for enthalpy control.

* + - * 1. Outside, Return, and Relief Dampers:

When supply fan is not running, outside and relief dampers are closed and return damper is open.

When supply fan is running, dampers are controlled and operate with outside and relief dampers opening, and return damper closing.

For cooling and outside air temperatures below 55 degrees F, modulate dampers to maintain [**mixed**] [**supply**] air temperature of 55 degrees F [**or higher**].

For cooling and outside air temperatures above 55 degrees F outside and relief dampers are open and return damper is closed.

For cooling and outside air temperatures above 55 degrees F compare return and outside air [**temperatures**] [**enthalpies**]. When return air [**temperature**] [**enthalpy**] is lower, drive outside damper to minimum, close relief damper, and open return damper.

For outside air temperatures above 79 degrees F, drive outside damper to minimum, close relief damper, and open return damper.

For heating, drive outside damper to minimum, close relief damper, and open return damper.

Modulate [**mixed air dampers**] [**preheat coil valve**] [**and face and bypass dampers**] [**and cooling coil valve**] in sequence to maintain [**constant**] [**mixed**] [**supply**] air temperature.

Use for multizone system. Use either feedback controls or controls specified for dual duct system.

* + - * 1. Multizone System:

[**Space sensor**] [**[Single] [Dual] temperature room thermostat**] set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature [**during day and 15 degrees F cooler at night**] by modulating zone dampers.

Room with highest heating demand modulates heating coil valve. [**Room thermostat with highest cooling demand modulates cooling coil valve.**]

Use for dual duct system. Feedback controls could be added as specified for multizone system.

* + - * 1. Dual Duct System:

Control hot deck by modulating heating coil valve in accordance with outdoor temperature reset schedule.

Use the following paragraphs to define outdoor reset schedule.

Control hot deck at maximum 135 degrees F at outdoor temperature of -30 degrees F, and minimum 75 degrees F at outdoor temperature of 75 degrees F, with straight line relationship between.

Maintain constant cold deck temperature of 55 degrees F by modulating cooling coil valve.

Reset hot and cold deck temperatures. Room thermostat with highest heating demand resets hot deck control temperature. [**Room thermostat with highest cooling demand resets cold deck control temperature.**]

Use for induction system. Add control to zone by exposure. Use solar compensators alone or with outdoor ambient thermostat.

* + - * 1. Induction System:

Control hot deck by modulating heating coil valve in accordance with outdoor temperature reset schedule.

Control zone temperature at maximum 135 degrees F at outdoor temperature of -30 degrees F, and minimum 55 degrees F at outdoor [**solar compensated**] temperature of 75 degrees F. Use straight-line relationship between high and low temperatures.

Use one of the following methods to control systems.

* + - * 1. Maintain constant supply static pressure of [**1.5 inches wg**] [**<\_\_\_\_\_\_\_\_> inches wg**] by modulating supply and return fan inlet vane dampers in sequence. Locate sensor minimum [**50 ft**] [**<\_\_\_\_\_\_\_\_> ft**] downstream of supply fan in supply air duct.
        2. Maintain constant supply static pressure of [**1.5 inches wg**] [**<\_\_\_\_\_\_\_\_> inches wg**] by modulating supply fan inlet vane dampers. Maintain constant building pressure of [**0.05 inches wg**] [**<\_\_\_\_\_\_\_\_> inches wg**] measured at grade by modulating return air fan inlet vane dampers.
        3. Maintain constant supply static pressure of [**1.5 inches wg**] [**<\_\_\_\_\_\_\_\_> inches wg**] by modulating supply fan inlet vane dampers. Maintain constant differential airflow rate between supply and return by modulating return fan inlet vane dampers from velocity pressure measurements in supply and return ducts.
        4. Reset supply static pressure lower until one VAV box damper is full open.
        5. Display:

Select or add required night shut down cycle.

System graphic.

System on/off indication.

System day/night mode.

System fan on/off indication.

Return fan on/off indication.

Preheat coil pump on/off indication.

Spray pump on/off indication.

Outside air temperature indication.

Mixed air temperature indication.

Fan discharge air temperature indication.

Reheat zone air temperature indication.

Return humidity indication.

Fan discharge temperature control point adjustment.

Return humidity control point adjustment.

Reheat zone control point adjustment.

Supply static pressure indication.

Supply static pressure control point adjustment.

Building static pressure indication.

Building static pressure control point adjustment.

Include the following for variable air volume systems.

Outside air flow rate.

The following only apply to control systems with local control points.

System on/off auto switch.

System day/night/auto switch.

Supply fan on/off switch.

Return fan on/off/auto switch.

Preheat coil pump on/off switch.

Spray pump on/off auto switch.

* + - 1. COMBUSTION AIR UNIT HEATERS

Use three-way valve where pressure bypass will not be used and wild flow circuit may be required.

* + - * 1. Single temperature room thermostat set at [**68 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant room temperature by modulating [**two-way**] [**three-way**] heating control valve.
        2. Single temperature thermostat on return heating water line de-energizes unit fan on temperature below [**95 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**].
      1. EXHAUST FANS

Include the following as applicable. This sequence can be used for elevator machine rooms, electrical rooms, and telephone rooms. It may not apply to some locations or where utility companies require closer control. Modern computer based equipment may require refrigeration equipment instead of ventilation for removal of heat.

* + - * 1. On room temperature above [**85 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**], open intake dampers and start exhaust fans.
        2. On room temperatures above [**90 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**], signal alarm.
      1. EMERGENCY GENERATOR WITH AUTOMATIC DAMPERS

Use the following two paragraphs for air-cooled units.

* + - * 1. When generator is not running, outside and exhaust dampers are closed and return damper is open.
        2. When generator is running, dampers are controlled and operate with outside and exhaust dampers opening, and return dampers closing, to maintain room temperature of [**85 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**].

Use the following paragraph for water-cooled units.

* + - * 1. On room temperatures above [**95 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] open intake damper and start exhaust fan.
        2. Provide solenoid valve to shut off fuel supply when generator is not operating.
      1. EXCESS PRESSURE CONTROLS

Select applicable control method.

* + - * 1. Maintain constant pressure differential between supply and return lines by [**modulating bypass valves**] [**cycling pumps in sequence**] [**varying pump speed through variable speed drive control**].
      1. FAN COIL UNITS

Use the following sequence for steam or hydronic heating.

* + - * 1. [**Single**] [**Dual**] temperature unit-mounted thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**]. Thermostat maintains constant space temperature [**during day and [15 degrees F] [<\_\_\_\_\_\_\_\_> degrees F] cooler at night**]. Thermostat [**modulates**] [**opens and closes**] two-way control heating valve [**with spring range of [3 to 7 psig] [3 to 13 psig]**].

Use the following sequence for hydronic heating and cooling units.

* + - * 1. [**Single**] [**Dual**] temperature unit-mounted thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature [**during day and [15 degrees F] [<\_\_\_\_\_\_\_\_> degrees F] cooler at night**]. Thermostat [**modulates**] [**opens and closes**] two-way control heating valve [**with spring range of 3 to 7 psig**] [**and two-way cooling control valve [with spring range of 8 to 13 psig]**] in sequence.

Use the following sequence for units having single coil and four-way control valve.

* + - * 1. [**Single**] [**Dual**] temperature unit-mounted thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature [**during day and [15 degrees F] [<\_\_\_\_\_\_\_\_> degrees F] cooler at night**]. Thermostat modulates four-way control valve. During heating cycle, thermostat modulates hot water supply to coil and diverts return water to heating return pipe. During cooling cycle, thermostat modulates chilled water supply to coil and diverts return water to cooling return pipe. When space thermostat is satisfied, there is no flow through coil.
        2. Change over from heating to cooling by indexing thermostat from thermostat on supply piping. When supply is above room temperature, operate thermostat in direct acting manner, opening valve when temperature falls below thermostat setting. When supply is below room temperature, operate thermostat in reverse acting manner, opening valve when space temperature rises above thermostat setting.
        3. For heating and cooling fan coil units with fan speed control during heating cycle, increase fan speed as space temperature falls below thermostat setting, when hot water is available. During cooling cycle, increase fan speed as space temperature rises above thermostat setting, when chilled water is available.
        4. Mount thermostat with adjustable knob and speed switch on common plate engraved with "Heating Control and Fan Control" on top, with "Warmer and Cooler" and direction indicator around thermostat knob.
      1. HEATING COILS

Use the following sequence for steam or hydronic heating. Select thermostat type required. Dual temperature is used for night setback. Select spring range when valve is pneumatic to complement integrated controls such as with terminal variable air volume (VAV) units, and to maintain consistency.

* + - * 1. [**Single**] [**Dual**] temperature thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature [**during day and [15 degrees F] [<\_\_\_\_\_\_\_\_> degrees F] cooler at night**]. Thermostat [**modulates**] [**opens and closes**] [**two-**] [**three-**] way control heating valve [**with spring range of [3 to 7 psig] [3 to 13 psig]**].

Where electric control is not packaged as integral part of electric heating unit, use the following, selecting appropriate type of control.

* + - * 1. Single temperature room thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature by [**energizing**] [**staging**] [**modulating electric output through action at SCR power controller, to**] electric heaters.
      1. HEATING WATER ZONE CONTROL
         1. [**Flow**] [**Pressure**] switch in heating pump discharge indicates on/off status.

Include indoor/outdoor controller here when not included as part of boiler controls. Select applicable control method.

* + - * 1. Control heating water supply temperature set at [**195 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] [**in accordance with outdoor reset schedule**] by [**modulating steam control valve**] [**modulating heating water control valve**] [**modular boiler gas valve**] [**step firing boilers**].

Use the following paragraph to define outdoor reset schedule.

* + - * 1. Control heating water at maximum [**195 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] at outdoor temperature of [**-30 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**]. Control heating water at minimum [**130 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] at outdoor temperature of [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**]. Use straight-line relationship between temperatures.

Use the following paragraph to define sequence of step firing boilers.

* + - * 1. Step fire boilers in sequence, [**Boiler No. 1 - low fire, Boiler No. 1 - high fire, Boiler No. 2 - low fire, Boiler No. 2 - high fire**] <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**>.

Include valve option where heat exchanger control is specified.

* + - * 1. [**Flow**] [**Pressure**] switch in heating water circuit on no flow conditions [**closes valve and**] indicates alarm.
        2. On outside temperatures above [**65 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**], de-energize heating pumps and suppress alarm.
        3. Display:

Edit and include desired items.

System graphic.

System supply-temperature.

System supply control point adjustment.

System return-temperature.

Pump on/off indication.

The following only apply to control systems with local control panels.

Pump on/off switch.

Boiler lead lag switch.

* + - 1. HUMIDIFIERS

Select humidifier operation and fluid.

* + - * 1. When fan is running [**and airflow switch proves airflow**], line voltage room humidistat [**reset from outdoors**] maintains humidity [**level of [30] <\_\_\_\_\_\_\_\_> percent**] by [**cycling unit fan and**] [**opening two position**] [**modulating**] two-way [**steam**] [**hot water**] valve.
        2. When supply fan is running [**and airflow switch proves airflow**] [**and there is water in humidifier sump**], humidistat located in return air, reset from outdoors [**modulates normally closed humidifier valve**] [**cycle spray pumps**] [**and modulates valve on spray header**]. Set outdoor reset to [**50**] <**\_\_\_\_\_\_\_\_**> percent relative humidity at [**70 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] and [**15**] <**\_\_\_\_\_\_\_\_**> percent relative humidity at [**-30 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**].
      1. INDUCTION UNITS

Edit to suit Project conditions. Control pressure range may be required to adequately clarify sequencing for system tape.

* + - * 1. [**Single**] [**Dual**] temperature unit mounted thermostat maintains constant space temperature at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] [**during day and [60 degrees F] [<\_\_\_\_\_\_\_\_> degrees F] cooler at night**]. Thermostat [**modulates**] [**opens and closes**] two-way control heating valve [**with spring range of [3 to 7 psig] [3 to 13 psig] [8 to 13 psig]**].
      1. PARKING GARAGE VENTILATION SYSTEMS

Typical sequence for direct-fired system is for exhaust fan interlock to automatically shut down ventilation system.

* + - * 1. Time Schedule: Stop exhaust fan at night.
        2. Carbon Monoxide (CO) detector maintains maximum CO level of 50 ppm by cycling exhaust fan. When CO level exceeds 100 ppm, signal alarm.
        3. When exhaust fan starts, start make-up unit.
      1. RADIANT PANELS

Use the following sequence for steam or hydronic heating.

* + - * 1. [**Single**] [**Dual**] temperature thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature [**during day and [15 degrees F] [<\_\_\_\_\_\_\_\_> degrees F] cooler at night**]. Thermostat [**modulates**] [**opens and closes**] two-way control heating valve [**with spring range of [3 to 7 psig] [3 to 13 psig]**].

Use the following sequence for hydronic heating and cooling units with four-way control valve.

* + - * 1. [**Single**] [**Dual**] temperature thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature [**during day and [15 degrees F] [<\_\_\_\_\_\_\_\_> degrees F] cooler at night**]. Thermostat modulates four-way control valve. During heating cycle, thermostat modulates hot water supply to coil, and diverts return water to heating return pipe. During cooling cycle, thermostat modulates chilled water supply to coil and diverts return water to chilled water supply to coil and divert return water to cooling return pipe. When space thermostat is satisfied no flow occurs through coil.
        2. Change over from heating to cooling by indexing thermostat from aquastat on supply piping. When supply is above room temperature, operate thermostat in direct acting manner, opening valve when temperature falls below thermostat setting. When supply is below room temperature, operate thermostat in reverse acting manner, opening valve when space temperature rises above thermostat setting.
      1. RADIATION [**AND CONVECTORS**]

Use the following sequence for steam or hydronic heating. Select thermostat type required. Dual temperature is used for night setback. Select spring range when valve is pneumatic to both complement integrated controls, and to maintain consistency.

* + - * 1. [**Single**] [**Dual**] temperature thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature [**during day and [15 degrees F] [<\_\_\_\_\_\_\_\_> degrees F] cooler at night**]. Thermostat [**modulates**] [**opens and closes**] two-way control heating valve [**with spring range of [3 to 7 psig] [3 to 13 psig]**].

Where electric control is not packaged as integral part of electric heating unit, use the following, selecting appropriate.

* + - * 1. Single temperature room thermostat set at [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature by [**energizing**] [**staging**] [**modulating electric output through action at SCR power controller, to**] electric heaters.
      1. REFRIGERATION SYSTEMS
         1. Maintain constant [**supply**] [**return**] air duct temperature of [**55 degrees F**] [**75 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] by cycling refrigeration system and signaling step capacity, minimum of <**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**> steps.
      2. AIR TERMINAL UNITS
         1. Single Duct Variable Volume Air Terminal Units (Cooling Only):

Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit damper modulates open to maximum air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates closed to its minimum air quantity.

Unoccupied Cycle: Air terminal damper is [**normally open**] [**normally closed**].

In the following paragraph, choose among 4 choices based on type of heat and control. Choices in order are as follows: staged electric heat, pulse width modulated electric heat, 2 position hot water valve, and modulating hot water valve.

* + - * 1. Single Duct Variable Volume Air Terminal Units (with Heating Coil):

Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit damper modulates open to maximum air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates closed to its minimum air quantity. As space temperature continues to fall to heating setpoint, air terminal unit damper modulates to heating minimum air quantity. Heating coil will [**stage on electric heat with [1] <\_\_\_\_\_\_\_\_> degree interval for each stage**] [**energize first stage of heat**]. [**Second [and third] stages of heat energized based on time and temperature deviation from setpoint**] [**drive open heating coil control valve**] [**modulate open heating coil control valve**].

Unoccupied Cycle: Air terminal damper is [**normally open**] [**normally closed**]. Heating is staged to maintain reduced space temperature. Heating coil control valve is [**normally open**] [**normally closed**].

* + - * 1. Dual Duct Variable Volume Air Terminal Units:

Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit cooling damper modulates open to maximum air quantity. Heating damper is fully closed. As space temperature drops below cooling setpoint, air terminal unit cooling damper modulates to minimum air quantity. As space temperature continues to drop to heating setpoint, air terminal unit heating damper modulates open to maximum air quantity.

Unoccupied Cycle: Cooling damper normally [**closed**] [**open**]. Heating damper normally [**open**] [**closed**].

In the following paragraph, choose among 4 choices based on type of heat and control. Choices in order are as follows: staged electric heat, pulse width modulated electric heat, 2 position hot water valve, and modulating hot water valve.

* + - * 1. Parallel Fan Powered Variable Volume Air Terminal Units:

Occupied Cycle: On rise in space temperature above cooling setpoint, air terminal unit damper modulates open to maximum cooling air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates closed to its minimum cooling air quantity. As space temperature continues to fall, unit fan is energized. Upon further drop in space temperature, air terminal unit damper modulates to minimum heating air quantity. Heating coil will [**stage on electric heat with [1] <\_\_\_\_\_\_\_\_> degree interval for each stage**] [**energize first stage of heat**]. [**Second [and third] stages of heat energized based on time and temperature deviation from setpoint**] [**drive open the heating coil control valve**] [**modulate open heating coil control valve**].

Unoccupied Cycle: Air terminal unit damper modulates fully closed. Terminal unit fan and heating coil cycle to maintain reduced space temperature.

In the following paragraph, choose among 4 choices based on type of heat and control. Choices in order are as follows: staged electric heat, pulse width modulated electric heat, 2 position hot water valve, and modulating hot water valve.

* + - * 1. Series Fan Powered Variable Volume Air Terminal Units:

Occupied Cycle: Unit fan operates continuously. On rise in space temperature above cooling setpoint, air terminal unit damper modulates to maximum cooling air quantity. As space temperature drops below cooling setpoint, air terminal unit damper modulates to minimum cooling air quantity. As space temperature continues to fall, air terminal unit damper modulates to minimum heating air quantity. Heating coil will [**stage on electric heat with [1] <\_\_\_\_\_\_\_\_> degree interval for each stage**] [**energize first stage of heat**]. [**Second [and third] stages of heat energized based on time and temperature deviation from setpoint**] [**drive open heating coil control valve**] [**modulate open heating coil control valve**].

Unoccupied Cycle: Air terminal unit damper modulates fully closed. Terminal unit fan and heating coil cycle to maintain reduced space temperature.

* + - 1. UNIT HEATERS

Use the following sequence for steam or hydronic heating.

* + - * 1. Single temperature electric room thermostat maintains constant space temperature of [**68 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] by cycling unit fan motor.
        2. Single temperature thermostat on return heating water line [**from floor mounted cabinet heaters**] de-energizes unit on temperatures below [**95 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**].

Use the following sequence for electric units. Use integral thermostat when available from manufacturer.

* + - * 1. Single temperature room thermostat set at [**68 degrees F**] [**<\_\_\_\_\_\_\_\_> degrees F**] maintains constant space temperature by cycling unit fan motor and energizing electric heating elements. [**Integral thermostat continues fan operation until element temperature falls below [100 degrees F] [<\_\_\_\_\_\_\_\_> degrees F].**]

END OF SECTION 230993