

SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. The work of this Section shall include, but is not limited to, the following:
 - 1. Supply and install necessary software, programming, sensing, controlling and controlled devices, piping, wiring and commissioning of automatic control systems, so as to provide a complete control system, meet requirements of control sequences specified.

1.02 RELATED DOCUMENTS

- A. Section 23 05 01 – HVAC General Provisions
- B. Section 23 09 23 – Building Management System (BMS)
- C. Section 28 31 00 – Fire Detection and Alarm

PART 2 – PRODUCTS

NOT USED

PART 3 – EXECUTION

3.01 GENERAL

- A. The purpose of this section is to show general modes of operations. Refer to drawings for equipment specific sequence of operations.
- B. Contractor shall provide customized control strategies and control sequences and define appropriate control loop algorithms and choose the optimum loop parameters for loop control. All control loops shall be tuned to stabilize within plus or minus 1 percent of setpoint within 5 minutes of setpoint change or start-up.
- C. Safety devices shall be hardwire-interlocked with “hand” and “automatic” positions in series with motor controller holding circuit.
- D. Smoke control, fire and life safety sequences shall override other automatic control sequences including hardwired safety devices.
- E. Reset schedules and setpoints shown in sequences are for initial programming and start-up. During system commissioning, the reset schedules and setpoints shall be fine-tuned to obtain desired thermal comfort, energy and ventilation system results.
- F. The intent of the reset schedules indicated is that the range of the output be limited between the minimum and maximum values indicated in the reset schedules.
- G. All functions which use analog points to switch equipment on and off (e.g., fans, pumps) must be programmed with dead bands, and if necessary, time delays to prevent short

cycling of equipment.

- H. Starting of fans and pumps shall have built-in time delays where a damper or valve is required to open or close prior to fan or pump pressure build-up.

3.02 SEQUENCE OF OPERATION

A. Modes of Operation Definition:

1. Occupied Mode:

- a. The system shall operate in Occupied Mode whenever the schedule indicates an occupied time period or when any zone control space temperature sensor override device is in the override position; or
- b. The warm-up or cool-down cycle is complete but the scheduled occupancy period start time has not been reached.

2. Warm-Up Mode:

- a. The BMS shall calculate a representative zone temperature based on the average of selected zone temperatures.
- b. An optimal start program shall determine the required start time to bring the building's representative space temperature to its occupied heating setpoint by the scheduled occupancy period.
- c. Warm-Up Mode shall be initiated if:
 - 1) The optimal start program determines that morning warm-up is required and the building is in Unoccupied Mode at the optimal start time.
- d. Warm-Up Mode shall end when:
 - 1) The representative zone temperature reaches setpoint, or
 - 2) Return air temperature rises above 68 degrees F, or
 - 3) A scheduled occupancy period has started, or
 - 4) The building enters after-hours override Occupied Mode.
- e. Upon ending Warm-Up Mode, the building shall enter Occupied Mode.

3. Cool-Down Mode:

- a. The BMS shall calculate a representative zone temperature based on the average of selected zone temperatures.
- b. An optimal start program shall determine the required start time to bring the building's representative space temperature to its occupied cooling setpoint by the scheduled occupancy period.
- c. Cool-Down Mode shall be initiated if: The optimal start program determines that cool-down is required and the building is in Unoccupied Mode at the optimal start time.
- d. Cool-Down Mode shall end when:
 - 1) The representative zone temperature reaches setpoint, or
 - 2) Return air temperature drops below 76 degrees F, or

- 3) A scheduled occupancy period has started, or
- 4) The building enters after-hours override Occupied Mode.
- e. Upon ending Cool-Down Mode, the building shall enter Occupied Mode.
- 4. Unoccupied Mode:
 - a. The building is considered to be in unoccupied operation whenever it is not in warm-up, cool-down or occupied operation.
 - b. The system shall not operate whenever the operating schedule indicates an unoccupied time period.
- 5. Fire Mode: The system shall run in this Mode based on input from the fire alarm system. This Mode shall have priority over all other control modes.

END OF SECTION 23 09 93