

UCCS Temperature Control-Specifiers Guide
Mechanical Division 15985: Control Sequence of Operation

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SECTION 15985

CONTROL SEQUENCE OF OPERATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Hot Water Heating.

B. Related Sections:

1. Section 15010 - Basic Mechanical Requirements.
2. Section 15190 - Mechanical Identification.
3. Section 15950 - Controls.
4. Section 15990 - Testing, Adjusting and Balancing.

1.02 SYSTEM DESCRIPTION

A. Design Requirements:

1. General:

- a. The intent of this design guide Section is to provide representative control sequences that the University has found satisfactory to use as an example in the final design of typical projects.
- b. The typical systems described are simple solutions to typical control designs. Before using them, be sure the control design for the project system is typical. Be aware that the final design is the responsibility of the Design Consultant.
- c. The University requires functional performance testing of the complete control system prior to Owner acceptance.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.01 SEQUENCE OF OPERATION

A. VAV AIR HANDLER

[Note to Consultant: Customize, edit, and include control sequences for each piece of equipment on the project to be controlled.]

1. The occupancy mode (Occupied-Unoccupied) shall be determined through a user-adjustable, graphical, seven-day schedule with an additional holiday schedule.
2. Occupied Mode:

- a. The supply fan shall be energized. The supply fan speed shall modulate to maintain duct static pressure setpoint of 1" w.g. initially (adjustable). The final setpoint shall be determined in consultation with the balancing contractor.
- b. Whenever the supply fan is energized, the return fan shall be energized. The return fan speed shall modulate to maintain the return air plenum pressure setpoint of 0.10" w.g. (adjustable).
- c. The outdoor air fan shall be energized and its damper shall be open.
- d. The exhaust air damper shall modulate to maintain the space static pressure setpoint of 0.05" w.g.
- e. Discharge air temperature setpoint shall be reset based upon outdoor air temperature according to the following reset schedule:

Discharge Air Temperature Setpoint	Outdoor Temperature
55°F > 70°F	
65°F < 30°F	

All parameters shall be independently adjustable.

- f. Evaporative Cooler Section [**include where applicable**]:
 1. Evaporative cooler pump shall not operate unless:
 - a. Outside dampers are 100% open.
 - b. Sump level switch is made.
 - c. Discharge air controller output is calling for the evaporative cooler pump(s) to be on.
 - d. High space humidity lock out is below 65% (adjustable).
 - e. Supply fan is on.
 2. Staging of evaporative cooler pumps (where applicable) shall use the output of the discharge air controller to stage the pumps.
 3. The evaporative cooler sump shall drain when the outside air temperature drops below 40F (adjustable) for 60 minutes (adjustable). The evaporative cooler sump shall fill only when the outside air temperature exceeds 55F.
 4. There shall be a daily dry-out cycle of 60 minutes (adjustable). This dry-out shall occur daily between 5 a.m. and 6 a.m. (adjustable).

B.

5. Program a weekly sump drainage cycle to coincide with the evaporative cooler pad dry-out period.
6. Spring Return:
 - a. Provide spring return for all AHU components (e.g., coil valves and dampers) to achieve the desired open or closed failure mode.
 - g. Indirect Tower Cooling Section [**include where applicable**]: Fill the tower sump if the outside air temperature is above 55°F (adjustable). Maintain tower sump water temperature by cycling tower fan's 'off-low-high' using a local temperature controller mounted to the tower sump. Provide hardwired time delay internal to the magnetic motor starter when going from fan high-speed to low-speed to allow for fan deceleration. The tower sump shall drain whenever the outdoor air temperature is below 35°F (adjustable) for 60 minutes (adjustable).
3. Unoccupied Mode:
 - a. The supply, return and minimum-outdoor-air fans shall be de-energized. Both outdoor air dampers and exhaust dampers shall be closed.
 - b. The heating coil valve and pump shall cycle to maintain mixed-air temperature of 45°F (adjustable).
4. Safety Shutdowns:
 - a. Duct smoke detection, high pressure safeties and low temperature limit trips shall de-energize the air-handling unit and close the outdoor air and exhaust air dampers.
5. Freeze-Protection
 - a. When the outdoor air temperature is below 40°F (adjustable) the HW and CHW pumps shall be energized continuously for freeze protection. The heating coil valve shall cycle as described elsewhere.
 - b. If the unit has shutdown on the low temperature limit switch, energize the return fan until the condition has been resolved.

CHILLED WATER SYSTEM [**Include where applicable**]

1. The chiller shall be enabled whenever the outside air temperature is above 55°F for 30 minutes (both adjustable). The chiller shall be disabled when the OAT drops below 54°F for 30 minutes (both adjustable).
 2. The chiller shall not be enabled unless the cooling tower sump is filled.
 3. The chiller shall start and stop the chilled water and condenser water pumps through its internal controls.
 4. The cooling tower fan shall sequence 'off-low-high' to maintain condenser water supply temperature setpoint of 74°F (adjustable). The fan shall be locked out
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whenever the chiller is de-energized.

5. The cooling tower sump drain and fill lines shall drain whenever the outdoor air temperature is less than 35°F for 30 minutes (both adjustable). The tower sump shall be filled whenever the OAT > 54°F for 30 minutes (both adjustable).
6. The chilled water supply temperature shall be reset from 45° to 52°F. The chilled water supply temperature shall be as warm as possible while attaining the discharge air temperature setpoint for the air handling unit.

Chilled Water Supply	
Temperature Setpoint	Outdoor Temperature
52°F	55°F
45°F	80°F

7. Activation of any emergency-stop switches or refrigerant-detection alarms shall de-energize all central plant equipment except makeup-air units and exhaust fans.

C. CABINET UNIT HEATER [**Include where applicable**]

1. The space thermostat shall modulate the control valve and cycle the unit fan to maintain space temperature at setpoint of 68°F. For steam heating, when steam is not available, as sensed by the aquastat, the fan shall be de-energized.

D. UNIT HEATER [**Include where applicable**]

1. For heating systems operating in winter only (no reheat), the space thermostat shall cycle the unit fan to maintain space temperature at setpoint of 68°F. For year-round heating/reheating, operate same as cabinet unit heater. For steam heating, when steam is not available as sensed by the aquastat the fan shall be de-energized.

E. BASE-BOARD HEATING [**Include where applicable**]

1. Fintube radiation shall be sequenced with the associated VAV box. Heating with fintube and cooling with the VAV box shall not occur simultaneously. For pneumatic controls, use non-overlapping spring ranges or sequencing relays on the fintube control valve and VAV damper actuator. For DDC, avoid overlap between heating and cooling unless needed to compensate for ventilation load. For DDC, actuator shall fail “in position” (no spring return).

F. VAV BOXES [**Include where applicable**]

1. A space thermostat varies the airflow from maximum to minimum and modulates the heating valve in sequence to maintain space temperature setpoint. The heating valve shall not begin to open until the airflow has reached its minimum setting. Pneumatic VAV controller compensates for variation in system pressure. Set minimum and maximum CFM as shown on the drawings. For DDC, actuator shall fail “in position” (no spring return).

G. REHEAT COILS [**Include where applicable**]

1. For DDC, actuator shall fail “in position” (no spring return).

H. FACE AND BYPASS PREHEAT COIL **[Include where applicable]**

1. Two-position preheat coil valve shall open full when outside air temperature is below 35F. Face and bypass dampers shall modulate to maintain 50F (adjustable) preheat coil discharge air temperature.

I. ANIMAL-HOLDING AREAS

1. Safety Shutdowns:
 - a. AHU heating coil will fail with heat off for small animal areas. Fail portion for large animal areas shall be approved by UCCS personnel..
 - b. AHU fan will turn off when hard-wired space sensor detects high temperature or low temperature at (adjustable) settings agreed to with UCB Controls Shop. Alarm contacts will connect to DDC system for remote alarming.

3.02 HOT WATER HEATING

A. Heating Water Supply:

1. A sub-master remote bulb thermostat, located in the heating water supply, shall maintain its setting by modulating in sequence, two normally closed control valves in parallel in the steam supply to the hot water heat exchanger. Fail safe operation of steam valve shall be to fail open.
2. Hot water supply temperature shall be reset inversely with changes in outside temperature by a master thermostat located on North Exposure.

B. Zone Control:

1. Building to be zoned as required by floors, orientation and function as determined for specific project.
2. Provide for each zone a night, week-end and holiday setback.
3. Provide each zone with adjustable morning warm-up time period.

- C. Temperature reset of a controlled variable is encouraged where overall system energy use will be minimized while still maintaining building temperature control requirements.

3.03 ELEVATOR SHAFT VENTING

*NOTE: The following is applicable only where required by the IBC.

- A. The following control sequence resulted from a meeting between UCB and the Boulder Fire Department staff to discuss what they prefer for control of the

elevator hoistway vent, based on UCB's requests for clarification to ICBO. We agreed on the following control sequence:

1. The vent for the elevator shaft shall have a motorized damper. This damper

shall be normally-closed (energized to open). The damper operator shall be electric only. pneumatic if control air is available in the building, electric otherwise. The damper shall be opened by a manually-operated remote switch. The switch shall be located in fire-alarm panel, or in or next to the elevator-recall panel if the building does not have a fire-alarm panel.

END OF SECTION