

SECTION 23 0994
HVAC SEQUENCE OF OPERATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sequence of operation for:
 - 1. Fan Interlocks.
 - 2. Air Terminal units.

1.02 SYSTEM DESCRIPTION

- A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.03 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements for submittal procedures.

1.04 REFERENCE STANDARDS

- A. KSU Metering Standard - 2016.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL

- A. All operators shall be in NORMAL position when each system is OFF.
- B. Provide smoke detector in supply air stream on all air systems over 2000 CFM. .
- C. Provide smoke detector in return or exhaust air stream on all air systems over 15,000 CFM. Provide system smoke isolation dampers which close when each system is off. Provide time delay on fan start to allow and verify opening of isolation dampers by end switches on dampers.
- D. Provide control power circuits to operate damper actuators in ductwork and dampers serving air handling systems.
- E. All temperatures are Fahrenheit.
- F. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated.
- G. When an air handling unit is not in operation, control devices shall remain in their "off" positions. "Off" positions may differ from the "normal" (meaning failed) position. Except as specified otherwise, "off" and "normal" positions of control devices shall be as follows:
 - 1. Heating Coil Valves:
 - a. "Off" Position: Closed.
 - b. "Normal" Position: Open.
 - 2. Cooling Coil Valves:
 - a. "Off" Position: Closed.
 - b. "Normal" Position: Closed.
 - 3. Outside Air Damper:
 - a. "Off" Position: Closed.
 - b. "Normal" Position: Closed.
 - 4. Exhaust/Relief Air Damper:
 - a. "Off" Position: Closed.
 - b. "Normal" Position: Closed.
 - 5. Variable Frequency Drive:
 - a. "Off" Position: Off.
 - b. "Normal" Position: Off.

- H. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified "proportional only" or "P+I", Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.
- I. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the DDC System start commands shall be staggered by 5 second (adj.) intervals to minimize inrush current.
- J. Alarm messages specified throughout the sequences shall be assigned to discrete priority levels. Priority levels dictate the handling and destination of alarm reports.
- K. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper password level, from the operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.
- L. When a power failure is detected in any phase, the DDC System start commands shall be retracted immediately from all electrically powered units served by the failed power source. If the associated primary control panel (ACP) is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the ACP is powered by uninterruptable power supply (UPS), or if ACP is not capable of monitoring its own power for use in sequences, Contractor shall provide at least one voltage monitor (three phase when applicable). When the DDC System detects that power has been restored, all equipment for which the DDC System start command had been retracted shall be automatically restarted on staggered 5 second intervals to minimize inrush current. When loss of equipment status coincides with a power failure, system shall not alarm individual equipment failures. Instead, only a single alarm shall be enunciated as follows:
 - 1. BUILDING POWER FAILURE: Acknowledge alarm when power is restored.
- M. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, the contractor shall determine a fixed reset schedule that shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance one of the following methods shall be employed. Obtain approval of reset schedule from the Design Professional. All parameters of reset schedule shall be adjustable without programming statement modifications.
- N. The DDC System shall provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:
 - 1. Speed control of variable speed drives.
 - 2. Chiller supply water temperature setpoint reset.
 - 3. Chiller demand limit.
 - 4. Travel rate of tower isolation and chiller isolation valves.
 - 5. Supply air duct static pressure setpoint reset.
 - 6. Supply air temperature setpoint reset for relative humidity control.
- O. Wherever a value is indicated to be dependent on another value (i.e.: setpoint plus 5°F) the DDC System shall use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points shall be provided. One to store the parameter (5°F), one to store the setpoint, and one to store the value which is the result of the equation.

3.02 COMMISSIONING TESTS

- A. Provide assistance to the Commissioning Authority (CxA) for scheduling and witnessing of testing.
- B. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.

3.03 MONITOR POINTS

- A. Arrangement: Locate all control points for a system within one DDC panel within the mechanical equipment room containing the majority of the equipment for that system.
- B. Each DDC controller including associated input/output modules, shall be provided with a minimum of 10% spare input and output points of each type installed, but no less than one point of each type.

3.04 MISCELLANEOUS FAN SEQUENCES

- A. Lab Exhaust Fan (EF-3): Runs continuous. Max CFM when occupied/Min CFM when unoccupied (interlock with ceiling occupancy sensor)
- B. Lab Exhaust Fan (EF-4A): Runs continuous. Shall interlock ON/OFF with future fume hood installation.
- C. Lab Exhaust Fan (EF-4B): Runs continuous.

3.05 AIR TERMINAL UNITS

- A. Fan Powered Series Induction Boxes:
 - 1. Unit fan(s) shall run continuously. Fans shall modulate from Min to Max as scheduled based on occupancy (interlock with ceiling occupancy ceiling) where scheduled.
 - 2. Room digital thermostat thru terminal unit controller modulates primary air damper actuator and N.O. 3-way valve in sequence to maintain setpoint temperature.