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# Spallation Neutron Source

FE & Klystron Building  
Air Handler & Penthouse Damper  
Controls  
Functional System Design (FSD)

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SNS Project Engineer



A U . S . D e p a r t m e n t o f E n e r g y M u l t i l a b o r a t o r y P r o j e c t

SPALLATION NEUTRON SOURCE

Argonne National Laboratory • Brookhaven National Laboratory • Lawrence Berkeley National Laboratory • Los Alamos National Laboratory • Oak Ridge National Laboratory

**Front End Air Handler & Exhaust Damper Controls Description**  
**Klystron Building Air Handler & Exhaust Damper Controls Description**  
**TD80002 Rev 1**

## **OPERATING PHILOSOPHY**

### Purpose:

The purpose of air handler and penthouse exhaust damper operation are to:

- a) control building space temperature to a setpoint selected by the operator
- b) provide proper response to smoke detection signal received from fire alarm system
- c) save energy by maintain building pressure slightly above the outside atmospheric pressure
- d) save energy by using outside air to cool the building when possible
- e) provide freeze protection
- f) provide the operator with modes of operation that insure adequate control and aid in trouble shooting and startup testing

### Assumptions:

- 1) Outside air will not be needed to heat the building.
- 2) Space temperature setpoints will not be automatically changed (such as between winter and summer). Manually changing the setpoints will be possible.
- 3) A mechanical stop will be provided to prevent the outside air damper from completely closing. This will provide a minimum of outside air at all times and enable the pressure control loop to function at all times.
- 4) MCCs for smoke exhaust fans/dampers are equipped with a Hand, OFF, Auto (HOA) switch that will prevent the logic from energizing the fan/damper if the switch is in the OFF position. This has been examined and found to be in compliance with an appropriate exception in NFPA 92A. Thus no special wiring or logic will be implemented to energize fans/dampers when the HOA switch is not in the AUTO position. However, a graphical alarm that obviously stands out from others will be presented to the operator whenever any smoke exhaust fan/damper is not in the AUTO position.
- 5) The Fire Alarm Control Panel (FACP) provides a hardwired signal to shutdown the air handler fan/damper in response to detection of smoke. The FACP must reset this shutdown signal when the smoke exhaust switch is actuated to permit the CF controls PLC to energize the fan and open the damper.
- 6) Freeze protection will be provided as follows:
  - a) when air handler internal temperatures fall below 45 degF, the logic will issue a command to close the outside air damper and generate an operator alarm
  - b) if the temperature continues to fall below 40 degF, the logic will:
    - De-energize air handler fans/dampers
    - Open the valves to heating coils closest to the outside air to 50% to add heat
    - Generate an operator alarm(Signals from the fire alarm system, would override these commands.)

## Operator Controls and Operating Modes

- 1) Cooling and heating space temperature setpoints – the temperatures to which the building is controlled by the outside air damper, chilled water valve, or heating water valve.
- 2) Building space pressure setpoint – the pressure to which the building is controlled by the exhaust damper
- 3) OFF: Air handler is not in use. Fan/damper is de-energized. Outside air damper is closed, heating valve is closed, chilled water valve is closed. Setpoints remain at last setting.
- 4) Auto: Logic determines how the space setpoint temperature is to be maintained (via heating control valve, chilled water control valve, or outside air damper) and automatically transitions from one configuration to the other as appropriate. Fan/damper is energized.
- 5) Heat: Air handler is forced to control space temperature with heat. Fan/damper is energized. Outside air damper is closed, chilled water valve is closed. Heating water valve is modulated.
- 6) Cooling with Outside Air: Air handler is forced to control space temperature with outside air. Fan/damper is energized. Outside air damper is modulated. Chilled water valve is closed, heating water valve is closed.
- 7) Cooling with Chilled Water: Air handler is forced to control space temperature with chilled water. Fan/damper is energized. Outside air damper is closed. Chilled water valve is modulated. Heating water valve is closed.
- 8) Space Pressure Control Auto: Building space pressure is controlled by modulating exhaust damper position.
- 9) Space Pressure Control Manual: Building space pressure is controlled by manually directing the exhaust damper position to a constant % open position.

## **OPERATOR INTERFACE DEFINITIONS**

### Local Hardware/Manual Operator Controls

- 1) HOA switch on MCC for fan/damper starter (*HS 2050, HS 2150, HS 2151, HS 2152, HS 2153, HS 2154*)
  - Note 1: Discharge damper solenoid hardwired to fan starter (damper open when fan on)
  - Note 2: FACP over-rides (hard-wired) fan/damper to the OFF/CLOSED position when smoke detected in return air or discharge air ducts
  - Note 3: If HOA switch is in OFF position, then the FACP cannot energize the fan/damper
- 2) FAULT indicator light on MCC
- 3) READY indicator light on MCC
- 4) RUN indicator light on MCC
- 5) Differential pressure gauge across AHU filter PF1 (*PDI 2050B, PDI 2150B, PDI 2151B, PDI 2152B, PDI 2153B, PDI2154B*)
- 6) Differential pressure gauge across AHU filter AF1 (*PDI 2050A, PDI 2150A, PDI 2151A, PDI 2152A, PDI 2153A, PDI2154A*)

- 7) Chilled water supply temperature gauge (*TI 2050G, TI 2150G, TI 2151G, TI 2152G, TI 2153G, TI 2154G*)
- 8) Chilled water return temperature gauge (*TI 2050F, TI 2150F, TI 2151F, TI 2152F, TI 2153F, TI 2154F*)
- 9) Heating water supply temperature gauge (*TI 2050E, TI 2150E, TI 2151E, TI 2152E, TI 2153E, TI 2154E*)
- 10) Heating water return temperature gauge (*TI 2050D, TI 2150D, TI 2151D, TI 2152D, TI 2153D, TI 2154D*)

#### Software HMI/EPICS Digital Operator Controls

- 1) Temperature control mode
  - a. OFF (default)
  - b. SEMI-AUTO – Heat only
  - c. SEMI-AUTO – Cool only w/outside air
  - d. SEMI-AUTO – Cool only w/chilled water
  - e. AUTO
- 2) Pressure control mode
  - a. Manual
  - b. AUTO (default)

#### Software HMI/EPICS Digital Displays

- 1) HOA switch status (*HS2050A, HS2150A, HS2151A, HS2152A, HS2153A, HS2154A*)
  - a. AUTO
  - b. NOT-AUTO
- 2) Fan/damper status (*F2050 / SOV2050 / FCV2050A, F2150 / SOV2150 / FCV2150A, F2151 / SOV2151 / FCV2151A, F2152 / SOV2152 / FCV2152A, F2153 / SOV2153 / FCV2153A, F2154 / SOV2154 / FCV2154A*)
  - a. RUN/OPEN
  - b. STOP/CLOSE
  - c. FAULT (no flow time-out after start)
- 3) Temperature control mode switch status
  - a. OFF (default)
  - b. SEMI-AUTO – Heat only
  - c. SEMI-AUTO – Cool only w/outside air
  - d. SEMI-AUTO – Cool only w/chilled water
  - e. AUTO
- 3) Pressure control mode switch status
  - a. MANUAL
  - b. AUTO
- 4) Smoke detector status (*NE2050A, NE2150A, NE2151A, NE2152A, NE2153A, NE2154A*)
  - a. NO SMOKE
  - b. SMOKE

- 5) Outside air damper enabled
  - a. ENABLED (Temperature above 45°F)
  - b. DISABLED (Temperature below 45°F)
- 6) Enthalpy status
  - a. Outside air enthalpy lower than return air
  - b. Outside air enthalpy higher than or equal to return air

#### Software HMI/EPICS Analog Operator Controls

- 1) Cooling SP (for FE building space)
- 2) Temperature heating SP (for FE building space)
- 3) Pressure SP (for FE building space)

#### Software HMI/EPICS Analog Displays

- 1) Building space temperature (*TT2050A, TT2150A, TT2151A, TT2052A, TT2053A, TT2054A*)
- 2) Building space pressure (*PT2050, PT2150, PT2151* )
- 3) Outside air temperature (*TT2050C, TT2150C, TT2154C*)
- 4) Outside air humidity (*MT2050C, MT2150C, MT2154C*)
- 5) Return air temperature (*TT2050B, TT2150B, TT2151B, TT2152B, TT2153B, TT2154B*)
- 6) Return air humidity (*MT2050B, MT2150B, MT2151B, MT2152B, MT2153B, MT2154B* )
- 7) Mixed air temperature (*TT2050D, TT2150D, TT2151D, TT2152D, TT2153D, TT2154D*)
- 8) AHU discharge flow (*FE2050 / FT2050, FE2150 / FT2150, FE2151 / FT2151, FE2152 / FT2152, FE2153 / FT2153, FE2154 / FT2154*)
- 9) OA/RA damper position command (% outside air) (*IP2050C / FCV2050C, IP2150C / FCV2150C, IP2151C / FCV2151C, IP2152C / FCV2152C, IP2153C / FCV2153C, IP2154C / FCV2154C*)
- 10) Chilled water valve position command (% open) (*IP2050B / TCV2050B, IP2150B / TCV2150B, IP2151B / TCV2151B, IP2152B / TCV2152B, IP2153B / TCV2153B, IP2154B / TCV2154B*)
- 11) Heating water valve position command (% open) (*IP2050A / TCV2050A, IP2150A / TCV2150A, IP2151A / TCV2151A, IP2152A / TCV2152A, IP2153A / TCV2153A, IP2154A / TCV2154A*)
- 12) Penthouse damper position command (% open) (*IP2050D / PCV2050D, IP2150D / PCV2150D, IP2150E / PCV2151D, IP2150F / PCV2152D, IP2150G / PCV2153D, IP2150H / PCV2154D, IP2151D / PCV2155D, IP2151E / PCV2156D, IP2151F / PCV2157D, IP2151G / PCV2158D, IP2151H / PCV2159D*)

#### Software HMI/EPICS Alarms (via EPICS Alarm Handler)

- 1) Space air temperature high and high-high
- 2) Space air temperature low and low-low

- 3) Space air humidity high and high-high
- 4) Space air humidity low and low-low
- 5) Space air pressure high and high-high
- 6) Space air pressure low and low-low
- 7) Smoke detected

## **OPERATIONAL MODES DESCRIPTIONS**

### Manual Local Fan/Damper Operation

- 1) Smoke must not be present in the discharge air duct (FACP hardwired over-ride)
- 2) HOA switch in MCC switched from OFF to HAND
- 3) Fan motor starter and discharge damper solenoid will be energized

### Software-Based System Startup

- 1) Smoke must not be present in return air or discharge air ducts (FACP hardwired over-ride)
- 2) HOA switch in MCC switched from OFF to AUTO
- 3) Penthouse exhaust damper position setpoint to approximately 30% open
- 4) Temperature control heating setpoint set
- 5) Temperature control cooling setpoint set
- 6) Temperature control mode selected
- 7) Fan turns on and discharge damper opens in all modes except OFF
- 8) Flow element confirms air flow
- 9) Temperature modulates as appropriate
- 10) Logic will ensure outside air damper is closed when the mixed air temperature is below 45°F
- 11) Logic will ensure fans/dampers are de-energized and heating valve is open to a minimum of 50% when the mixed air temperature is below 40°F
- 12) System automatically shuts down under the following conditions:
  - a. Smoke detected in return air or discharge air ducts (hardwired)

### Software-Based Semi-Automatic Heating Mode

- 1) Follow the software-based system startup procedure
- 2) Only the HEATING SETPOINT is active, the COOLING SETPOINT will be ignored
- 3) Logic will ensure the outside air damper is closed
- 4) Logic will ensure the chilled water control valve is closed
- 5) Logic will modulate the heating water control valve as appropriate

### Software-Based Semi-Automatic Cooling Mode Using Outside Air

- 1) Follow the software-based system startup procedure
- 2) Only the COOLING SETPOINT is active, the HEATING SETPOINT will be ignored

- 3) Logic will ensure the heating water control valve is closed
- 4) Logic will ensure the chilled water control valve is closed
- 5) Logic will modulate the outside air damper as appropriate

#### Software-Based Semi-Automatic Cooling Mode Using Chilled Water

- 1) Follow the software-based system startup procedure
- 2) Only the COOLING SETPOINT is active, the HEATING SETPOINT will be ignored
- 3) Logic will ensure the outside air damper is closed
- 4) Logic will ensure the heating water control valve is closed
- 5) Logic will modulate the chilled water control valve as appropriate

#### Software-Based Automatic Temperature Control

- 1) Follow the software-based system startup procedure
- 2) Both the COOLING SETPOINT and the HEATING SETPOINT are active
- 3) Logic will ensure outside air damper is closed when mixed air temperature is below 45°F
- 4) Logic will modulate the outside air damper as defined in the Control Logic Description (CHW and HW valves closed)
- 5) Logic will ensure outside air damper is closed when outside enthalpy exceeds the return air enthalpy
- 6) Logic will modulate the heating water control valve as defined in the Control Logic Description (OA and CHW valves closed)
- 7) Logic will modulate the chilled water control valve as defined in the Control Logic Description (OA and HW valves closed)

#### Software-Based Manual Pressure Control

- 1) Damper position manually set

#### Software-Based Automatic Pressure Control

- 1) PRESSURE THRESHOLD SETPOINT set
- 2) Logic will modulate penthouse exhaust damper to maintain PRESSURE THRESHOLD SETPOINT as appropriate

#### Control Logic Description

In the OFF mode, the air handler and penthouse exhaust damper are not in use. The dampers and all control valves are closed.

In the AUTO mode, the logic automatically determines what is to be done as follows:

The software-based system startup procedure provides appropriate initial conditions.

The logic calculates a midrange temperature setpoint (MPS) that is midway between the automatic cooling and heating control loop setpoints.

If the building space temperature is greater than the midrange setpoint (MPS) then cooling will be supplied. If the enthalpy calculation shows that outside air can be used, the chilled water valve will be closed and the outside air damper control loop will be used. If not, the outside air damper will be closed and the chilled water control loop will be used. If controlling with outside air and the outside air damper position output is greater than 90 %, then the outside air damper will be closed and the chilled water control loop will be used. In both cases, control will be to the cooling setpoint.

If the building space temperature is less than the midrange setpoint (MPS) then heating will be supplied by having the heating water valve control to the heating setpoint.

Semi-automatic modes force the air handler to cool with outside air by modulating the outside air damper, cool with chilled water by modulating the chilled water valve, or heat by modulating the heating water valve respectively.

In AUTO mode, the space air pressure loop controls the building air pressure by modulating the penthouse exhaust damper. In MANUAL, the controller is used to place it in a fixed position.

Screens













