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Spallation Neutron Source

Ring MakeUp Air Handler, Tunnel
Exhaust Damper, and Smoke
Removal
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

**Ring Makeup Air Handler, Tunnel Exhaust Damper, and Smoke Damper Controls
Description
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Operating Philosophy

Purpose:

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

- a) Condition outside and/or tunnel return air to an appropriate temperature and humidity and deliver it to the Ring tunnel
- b) Allow tunnel air to exit the tunnel at the exhaust point in the line to the Linac dump
- c) Respond to tunnel control commands from the tunnel operation screen
- d) Respond to a signals from PPS, the ODH and the fire alarm systems
- e) Provide the operator with modes of operation that insure adequate control and aid in trouble shooting and startup testing
- f) Provide freeze protection
- g) Provide manual actuation of smoke removal equipment from the tunnel operating screen

Assumptions:

- 1) From the tunnel operations screen, the East and West Air handlers operate simultaneously. That is, both need to be in the same mode at all times. Further, corresponding setpoints should be the same for both. The Air handler supply air (smoke) damper will be closed when the air handler is de-activated and open when the air handler is activated in all modes of operation.
- 2) Outside air and return air dampers will not be used for energy saving measures. They will be set to 100% outside air in the ventilation mode and 100% inside air during re-circulation mode and will not be modulated at any time.
- 3) Temperature setpoints will not be automatically changed (such as between winter and summer. Manually changing the setpoints will be possible.
- 4) The pre-heat and cooling coil temperature setpoints will be less than the air handler discharge temperature.
- 5) Receipt of the fire alarm, ODH, or PPS signals will place the air handler in the appropriate configuration. It will remain in this state until operator action is taken from the tunnel operation screen (automatic reset will not be permitted).
- 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
 - 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, ODH, and PPS systems, would override these commands.)

Operator Controls and Operating Modes

- 1) Pre-heat, chilled water valve, and re-heat valve setpoints – the temperatures to which the pre-heat and cooling coil discharge air, and air handler unit discharge air are controlled.
- 2) Unless signals are received from the fire alarm, ODH or PPS, the freeze protection action described above will occur in all modes.
- 3) OFF: Tunnel exhaust damper is closed. Air handler is not in use. Fan is de-energized. Outside air damper is closed, heating valve is closed, chilled water valve is closed. Setpoints remain at last setting.
- 4) AUTO: Respond to tunnel operation commands, PPS, ODH, and fire alarm signals as follows:
 - a. Standby tunnel operation command: Place air handler in OFF configuration. Tunnel exhaust damper is closed.
 - b. Re-Circulation tunnel operation command: Air handler re-circulates tunnel air at appropriate air flow (outside air damper is closed). Smoke and RTBT tunnel exhaust dampers closed. Return air temperature controlled.
 - c. Ventilation tunnel operation command: Air handler uses outside air only at appropriate air flow (return air damper is closed). Tunnel exhaust damper is open. Smoke damper is closed. Controls operate to control air handler discharge temperature at its setpoint.
 - d. Smoke Exhaust tunnel operation command: Air handler uses outside air only at appropriate air flow (outside air damper open, return air damper closed). Smoke exhaust damper open. RTBT tunnel exhaust damper closed. No temperature or humidity control provided.
- 5) Receipt of fire alarm, ODH system signal: Place air handler and smoke damper in Ventilation configuration. On receipt of the PPS signal, place it in the Re-Circulation configuration.
- 6) Pre-Heat Only: Air handler is forced to control pre-heat coil discharge temperature only. Fan is controlled at 4,000 CFM. Outside air damper is open, cooling coil and re-heat coil water valves are closed. Pre-heat coil water valve is modulated.
- 7) Cooling Only: Air handler is forced to control cooling coil temperature only. Fan is controlled at 4,000 CFM. Outside air damper is open, pre-heat coil and re-heat coil water valves are closed. Cooling coil water valve is modulated.
- 8) Re-Heat Only: Air handler is forced to control air handler discharge temperature only. Fan is controlled at 4,000 CFM. Outside air damper is open, cooling coil and pre-heat coil water valves are closed. Re-heat coil water valve is modulated.

OPERATOR INTERFACE DEFINITIONS

Local Hardware/Manual Operator Controls

- 1) Air handler filter differential pressures (*PDI2351A, PDI2351B*)
- 2) Re-heat hot water return temperature (*TI2351D*)
- 3) Re-heat hot water supply temperature (*TI2351E*)
- 4) Cooling chilled water return (*TI2351F*)

- 5) Cooling chilled water supply (*TI2351G*)
- 6) FAULT indicator light on MCC
- 7) READY indicator light on MCC
- 8) RUN indicator light on MCC

Software HMI/EPICS Digital Operator Controls

- 1) Temperature Control Mode
 - a. OFF (default)
 - b. SEMI-AUTO – Pre-heat only
 - c. SEMI-AUTO – Cooling only
 - d. SEMI-AUTO – Re-heat only
 - e. Recirculation Auto
 - f. Ventilation Auto

Software HMI/EPICS Digital Displays

- 1) Temperature Control Mode switch status
 - a. OFF (default)
 - b. SEMI-AUTO – Pre-heat only
 - c. SEMI-AUTO – Cooling only
 - d. SEMI-AUTO – Re-heat only
 - e. Recirculation Auto
 - f. Ventilation Auto
- 2) Fan/Discharge Damper Status (*F2351, SOV2351E*)
- 3) Fan/Outside Damper Status (*F2351, SOV2351D*)
- 4) Fan/Exhaust Damper Status (*F2351, SOV2354*)
- 5) Smoke Exhaust Fan (*F2351B*)
- 6) HOA switch status (*HS2351*)
- 7) Smoke detector (*NE2351*)

Software HMI/EPICS Analog Operator Controls

- 1) Pre-heat temperature setpoint
- 2) Cooling temperature setpoint
- 3) Re-heat temperature setpoint

Software HMI/EPICS Analog Displays

- 1) Pre-heat and cooling coil discharge air temperature (*TT2351A*)
- 2) Air handler discharge temperature (*TT2351B*)
- 3) Air handler discharge flow (*FT2351A*)
- 4) Outside air temperature (*TT2351C*)
- 5) Return air temperature (*TT2351D*)
- 6) Return air humidity (*MT2351D*)
- 7) Space temperature (*TT2351E*)

- 8) RTBT tunnel exhaust flow as indicated from flow measured at the Central Exhaust Building. (*FT2354*)
- 9) Fan speed feedback (*ST2351*)
- 10) Control valve outputs (from faceplate display) (*IP2351A, IP2351B, IP2351C*)

Alarms

- 1) Pre-heat and cooling coil discharge air temperature high and low
- 2) Pre-heat and cooling coil discharge air less than 45 degF
- 3) Pre-heat and cooling coil discharge air less than 40 degF
- 4) Air handler discharge air temperature high and low
- 5) Air handler discharge flow temperature high and low
- 6) Tunnel exhaust flow low
- 7) System not in Auto
- 8) Receipt of fire alarm system signal
- 9) Receipt of PPS system signal
- 10) Receipt of ODH system signal

Control Logic States & Description

Control Logic Description

In the OFF mode, the air handler and tunnel exhaust fans and dampers are not in use. Air handler outside and return air dampers are set to 100% inside air. The air handler supply (smoke) damper is closed and all control valves are closed. The smoke exhaust fan is de-energized and its damper is closed, and the RTBT tunnel exhaust damper is closed.

Unless signals are received from the fire alarm, PPS, or ODH systems, the freeze protection actions described above will be activated.

In AUTO mode, the logic will provide operating configurations as described below. Commands for these configurations are provided from the Tunnel Operations screen. The air handler supply (smoke) damper will be opened whenever the fan speed setpoint is greater than zero.

Re-Circulation:

- 1) Re-heat control valve closed
- 2) Outside air and return air dampers set to 100% return air
- 3) Fan is turned on and VFD modulating to a setpoint of 32,000 CFM
- 4) Chilled water valve modulated to maintain space temperature at the cooling setpoint (default of 82 degF)
- 5) Tunnel exhaust damper is closed
- 6) Tunnel smoke removal fan is de-energized and its damper is closed.

Ventilation

- 1) Mode switch is in VENTILATION
- 2) Outside air and return air dampers set to 100% outside air
- 3) Fan is turned on and VFD modulating to a setpoint of 4,000 CFM
- 4) Modulate pre-heat and chilled water control valves to maintain the pre-heat and cooling coil discharge air temperature at the pre-heat and cooling setpoints.
- 5) Modulate the re-heat water control valve to maintain the tunnel space temperature at the re-heat setpoint (default of 82 degF).
- 6) RTBT Tunnel exhaust damper is open
- 7) Tunnel smoke removal fan is de-energized and its damper is closed.

Smoke Exhaust

- 1) Mode switch is in SMOKE EXHAUST or fire alarm signal indicating smoke is present has been received.
- 2) Re-heat control valve, cooling control valve, and pre-heat control valve will be closed.
- 3) Outside air and return air dampers set to 100% outside air
- 4) VFD modulating to a setpoint of 28,000 CFM
- 5) No temperature or humidity control is provided.
- 6) RTBT Tunnel exhaust damper is closed.
- 7) Tunnel smoke removal fan is energized and its damper is open.

Semi-Auto (Pre-Heat Only)

- 1) Cooling control valve and re-heat control valve are closed
- 2) Fan is turned on, modulate pre-heat control valve to maintain Pre-heat setpoint
- 3) Tunnel smoke removal fan is de-energized and its damper is closed.
- 4) Tunnel exhaust damper is closed

Semi-Auto (Cooling Only)

- 1) Pre-heat control valve and re-heat control valve are closed
- 2) Fan is turned on, modulate cooling control valve to maintain Cooling setpoint
- 3) Tunnel smoke removal fan is de-energized and its damper is closed.
- 4) Tunnel exhaust damper is closed

Semi-Auto (Re-heat Only)

- 1) Pre-heat control valve and cooling control valve are closed
- 2) Fan is turned on, modulate re-heat control valve to maintain Re-heat setpoint
- 3) Tunnel smoke removal fan is de-energized and its damper is closed.
- 4) Tunnel exhaust damper is closed

