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Spallation Neutron Source

Linac Tunnel Makeup Air Handler & Tunnel Exhaust Damper Functional System Design (FSD)

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APPROVED
BY: David Meyer
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J. E. Cleaves 3/3/03
SNS Project Engineer

SNS

Linac Tunnel Makeup Air Handler & Tunnel Exhaust 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 air to an appropriate temperature and humidity and deliver it to the Linac 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 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

Assumptions:

1) The air handler and tunnel exhaust will only be in use when the tunnel is open and the beam is off and will run continuously during this period.
2) Outside air and discharge dampers will be closed when the air handler is de-activated and fully open when it is activated. (Modulation of dampers for control is not needed). Damper positions will be determined by hardwiring in the MCC (no PLC logic is needed).
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 generate an operator alarm
   b) if the temperature falls 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, ODH, and PPS systems, would override these commands.)

<u>Operator Controls and Operating Modes</u>

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/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: 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: Place air handler in OFF configuration. Tunnel exhaust damper is closed.
   c. Ventilation tunnel operation command: Fan is energized. Damper is open. Tunnel exhaust damper is open. Controls operate to control air handler discharge temperature at its setpoint.
   d. Smoke Exhaust tunnel operation command: Place air handler in OFF configuration. Tunnel exhaust damper is closed.
   e. Receipt of fire alarm, ODH system or PPS signal: Place air handler in OFF configuration. Tunnel exhaust damper is closed.
5) Pre-Heat Only: Tunnel exhaust damper is open. Air handler is forced to control pre-heat coil discharge temperature only. Fan/damper is energized. Outside air damper is open, cooling coil and re-heat coil water valves are closed. Pre-heat coil water valve is modulated.
6) Cooling Only: Tunnel exhaust damper is open. Air handler is forced to control cooling coil temperature only. Fan/damper is energized. Outside air damper is open, pre-heat coil and re-heat coil water valves are closed. Cooling coil water valve is modulated.
7) Re-Heat Only: Tunnel exhaust damper is open. Air handler is forced to control air handler discharge temperature only. 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

<u>Local Hardware/Manual Operator Controls</u>

1) Air handler filter differential pressures *(PDI 2104A, PDI 2104B)*
2) Re-heat hot water return temperature *(TI 2104D)*
3) Re-heat hot water supply temperature *(TI 2104E)*
4) Cooling chilled water return *(TI 2104F)*
5) Cooling chilled water supply *(TI 2104G)*
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. 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. AUTO
2) Fan/Discharge Damper Status *(F 2104/SOV 2104A/FCV 2104E)*
3) Fan/Outside Damper Status *(F 2104/SOV 2104B/FCV 2104D)*
4) Fan/Exhaust Damper Status *(F 2104/SOV 2107/FCV 2107)*
5) HOA switch status *(HS 2104A)*
6) Smoke Detector Status *(NE 2104)*

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 *(TT2104B)*
2) Air handler discharge temperature *(TT2104A)*
3) Outside air temperature *(TT2104C)*
4) Re-heat hot water control valve controller outputs *(IP 2104A/TCV 2104A)*
5) Cooling chilled water control valve controller outputs *(IP 2104B/TCV 2104B)*
6) Pre-heat hot water control valve controller outputs *(IP 2104C/TCV 2104C)*
7) Air handler discharge flow *(FE 2104/FT 2104)*
8) Exhaust air flow *(FE 2107/FT 2107)*

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) Tunnel exhaust flow low

Control Logic Description

Control Logic Description

In the OFF mode, the air handler is deactivated and the tunnel exhaust damper is closed. In AUTO mode, the logic will provide operating configurations as described above. In configurations where the air handler is active, the tunnel exhaust damper is open and the air handler is activated by energizing the fan/damper and activating temperature control loops.

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

Automatic temperature controls used in the AUTO mode work as follows:

The pre-heat, cooling, and reheat control valves are modulated to control temperatures at their setpoints.

If the outside temperature is such that the pre-heat and cooling coil discharge temperature is less than or close to the pre-heat temperature setpoint (53 degF), pre-heat valve will be controlling. The cooling PID algorithm will close the cooling valve because the pre-heat and cooling water temperature is below the cooling temperature setpoint (55 degF). The re-heat coil will add heat by modulating the re-heat valve to maintain the desired reheat temperature setpoint (75 degF)

If the outside temperature is such that the pre-heat and cooling coil discharge temperature is greater than the pre-heat setpoint (53 degF), the pre-heat PID algorithm will close the pre-heat control valve. The cooling control valve will modulate to maintain the pre-heat and cooling discharge air temperature at the cooling temperature setpoint (55 degF) and the re-heat valve will modulate to maintain the air handler discharge at its reheat temperature setpoint (75 degF).