108050000-TD0013-R00

Spallation Neutron Source

CHL Air Handler & VAV Terminal Damper

Functional System Design (FSD)

July, 2002

_____

SNS Project Engineer

CHL Air Handler & VAV Terminal Damper Controls Description TD80013

1. Operating Philosophy

1.1. Purpose

The purpose of air handler and VAV terminal damper operations are to:

a) Control the high bay space and two zone air temperatures
b) Save energy by using outside air to cool the building when possible
c) De-energize supply and return fans/dampers upon detection of smoke
d) Provide the operator with modes of operation that insure adequate control and aid in trouble shooting and startup testing
e) Provide freeze protection

1.2. Assumptions

1. Outside air will not be needed to heat the building.
2. The high bay space temperature will be varied as needed to maintain zone temperatures at their setpoint. It may not always be possible to maintain this temperature at its setpoint
3. Space temperature setpoints will not be automatically changed (such as between winter and summer). Manually changing the setpoints will be possible.
4. Fans/dampers are interlocked by the PLC logic so that the return air fan/damper is energized only when the supply air fan/damper is energized. (Note: No differential pressure switch exists to detect that the supply fan/damper is not running.)
5. A smoke damper in the air handler outlet must be closed when the air handler fan/damper is de-energized and open when the fan/damper is energized. This action is provided by hardwiring in the MCC, not PLC logic. Closing the damper in response to a smoke detection signal from the fire alarm system is accomplished by de-energizing the fan/damper.
6. 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.
7. A minimum damper position (30%) for the VAV terminals will be maintained to provide adequate air flow for the heating coil.
8. 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.

9. 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.
10. 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:
        i. De-energize air handler fans/dampers
        ii. Open the valves to heating coils closest to the outside air to 50% to add heat
        iii. Generate an operator alarm
11. Signals from the fire alarm system, would override these commands.

1.3. 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. OFF: Air handler and VAV terminals are not in use. Fans/dampers are de-energized. All dampers are closed, heating valve is closed and chilled water valve is closed. Setpoints remain at last setting.
3. Auto: Logic determines how the space setpoint temperature is to be maintained (via heating control valve, chilled water control valve, or outside air and exhaust dampers) and automatically transitions from one configuration to the other as appropriate. Fans/dampers are energized. VAV terminal dampers are modulated.
4. Heat: Air handler is forced to control space temperature with heat. Fans/dampers are energized. Outside air damper is closed, economizer damper is closed, and chilled water valve is closed. Heating water valve is modulated. VAV terminal dampers are modulated.
5. Cooling with Outside Air: Air handler is forced to control space temperature with outside air. Fans/dampers are energized. Economizer damper is closed. Outside air and exhaust dampers are modulated. Chilled water valve is closed. Heating water valve is closed. VAV terminal dampers are modulated.
6. Cooling with Chilled Water: Air handler is forced to control space temperature with chilled water. Fans/dampers are energized. Economizer damper is open. Outside air and exhaust dampers are closed. Chilled water valve is modulated. Heating water valve is closed. VAV terminal dampers are modulated.

2. Operator Interface Definitions

2.1. Local Hardware/Manual Operator Controls

1. HOA switch on MCC for return fan/damper starter *(HS2601)*
2. HOA switch on MCC for supply fan/damper starter *(HS2600)*
3. Pressure differential indicator across air filter PF1 *(PDI2600B)*
4. Pressure differential indicator across air filter AF1 *(PDI2600A)*
5. Chilled water supply temperature indicator *(TI2600G)*
6. Chilled water return temperature indicator *(TI2600F)*
7. Heated water supply temperature indicator *(TI2600E)*
8. Heated water return temperature indicator *(TI2600D)*
9. VAV Terminal heated water return temperature indicator *(TI2600H,K)*
10. VAV Terminal heated water supply temperature indicator *(TI2600J,L)*
11. FAULT indicator light on MCC
12. READY indicator light on MCC
13. RUN indicator light on MCC

2.2. Software HMI/EPICS Digital Operator Controls

1. Temperature control mode (selection switch)
    a. Off
    b. Manual-Heat
    c. Manual-Cool W/OA
    d. Manuel-Cool W/CHW
    e. Auto

2.3. Software HMI/EPICS Digital Displays

1) Mode switch status
    a. OFF
    b. Auto
    c. Manual-Heat
    d. Manual-Cool W/OA
    e. Manual-Cool W/CHW
2) Smoke detector status from fire alarm system *(NE2600)*
3) Differential pressure switch status *(PDS2600B)*
4) Supply air fan/damper HOA switch status *(HS2600A)*
5) Return air fan/damper HOA switch status *(HS2600 B)*
6) Return air fan/damper status *(F2600B)*
7) Supply air fan/damper status *(F2600A/SOV2600/FCV2600F)*

2.4. Software HMI/EPICS Analog Operator Controls

1. Temperature cooling sp (return air for building space)
2. Temperature heating sp (return air for building space)
3. Zone temperature sp (zone temperatures)

2.5. Software HMI/EPICS Analog Displays

1. Outside air temperature *(TT2600D)*

2. Outside air humidity *(MT2600D)*
3. Return air temperature *(T 2600C)*
4. Return air humidity *(MT2600C)*
5. Mixed air temperature *(TT2600B)*
6. Supply air temperature *(TT2600E)*
7. Zone air temperatures *(TT2600A , TT2600F, TT2600H)*
8. Supply air flow via Air Flow Monitoring System (*FT2600)*
9. Exhaust air damper controller output *(IP2600C/FCV2600C)*
10. Outside air damper controller output *(IP2600E/FCV2600E)*
11. Economizer damper controller output n *(IP2600D/FCV2600D)*
12. VAV terminal #1 damper controller output *(IP2600G/FCV2600G)*
13. VAV terminal #2 damper controller output *(IP2600J/FCV2600H)*
14. Heated water valve controller output (% open) *(IP2600A/TCV2600A)*
15. Chilled water valve controller output (% open) *(IP2600B/TCV2600B)*
16. VAV terminal #1 heated water valve controller output (% open) *(IP2600F/TCV2600F)*
17. VAV terminal #2 heated water valve controller output (% open) *(IP2600H/TCV2600H)*

2.6. Software HMI/EPICS Alarms (via EPICS Alarm Handler)

1. Return (space) air temperature low and high
2. Return (space) air humidity low and high
3. Zone air temperatures low and high
4. Mixed air temperature low (40 degF)
5. Smoke detected

3. Operational Modes Descriptions

3.1. Control Logic Description

In the OFF mode, the air handler and VAV terminal are not in use. The dampers and all control valves are closed.

Unless signals are received from the fire alarm, PPS, or ODH systems, the freeze protection actions described in Section 1.2.9 will be activated.

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

If the return air temperature is less than the setpoint (72 degF) then heating will be supplied by closing the outside, exhaust, and economizer dampers and modulating the heating coil valve to maintain the return air temperature at setpoint.

If the return air temperature is greater than the 75 degF, the heating valve will be closed and cooling will be provided as follows:

If the enthalpy calculation shows that outside air can be used and the return air temperature is less than 85 degF, the outside air damper control loop will be used to modulate the outside and exhaust dampers simultaneously. If not, the chilled water control loop will be used to

modulate the chilled water control valve. In both cases, control will be to the high bay space temperature setpoint.

The VAV terminal dampers will be modulated to control the zone temperatures to setpoints selected by the operator. As the heat load decreases, the zone terminal dampers will begin to close. When either damper is at minimum position (see assumption 7), start opening the hot water valve and use it to control the temperature. When the hot water valve reaches full open, reset (increase) the high bay space temperature setpoint by 5 degF. As the heat load increases, the hot water valve will be closed prior to the zone terminal dampers beginning to open. When either damper is fully open, reset (decrease) the high bay space temperature by 5 degF. The resetting of the setpoint (either up or down) can only occur once in a direction until the other direction has been attained. Therefore, if the setpoint has been adjusted down after either VAV damper has reached 100%, the setpoint cannot be adjusted down again until one of the VAV dampers has reached minimum position. This will ensure the setpoint will not deviate more than 5 degrees up or down from the original setpoint.

In the manual modes the air handler is forced 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.