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## Spallation Neutron Source

### Tunnel Operations Functional System Design (FSD)

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SPALLATION NEUTRON SOURCE

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

## **Tunnel Operations Description TD8001 Revision 1**

### **Operating Philosophy**

#### Purpose:

The purpose of accelerator tunnel operations is to:

- a) Control air handler, ventilation, and smoke removal equipment in the Linac and Ring tunnels in a coordinated fashion to provide Re-Circulation, Ventilation, and Smoke Removal modes of operation.
- b) Condition outside and/or tunnel return air to appropriate temperatures
- c) Provide interactions with the PPS, ODH, and Fire Alarm systems to place tunnel equipment in appropriate configurations with respect to beam operation and smoke presence.
- d) Provide freeze protection for air handler equipment with outside dampers.

#### Assumptions:

- 1) Detailed requirements for control of equipment are provided in separate documents. This document only deals with overall tunnel operation.
- 2) No energy savings measures will be taken for the tunnels (other than heating to a lower setpoint than cooling).
- 3) No control of tunnel air pressure or humidity will be provided.
- 4) Linac and Ring tunnels will be operated independently via two overview screens – one for the Linac Tunnel and one for the Ring tunnel. Manually selecting a mode for one tunnel will not cause action in the other.
- 5) Both tunnels will be provided with operating modes as follows:
  - a. Standby – No HVAC action. All fans will be de-energized. All dampers will be closed or in re-circulation configuration (outside dampers closed).
  - b. Re-Circulation – Air will be recycled through air handlers. No outside air will be input to the tunnels and no tunnel air will be exhausted from them.
  - c. Ventilation – Outside air will be brought in through the Linac Makeup air handler or the two Ring Makeup air handlers. Linac tunnel air will be exhausted from the exhaust damper in the Linac dump tunnel area to the Central Exhaust Building. Ring tunnel air will be exhausted from the exhaust damper in the RTBT tunnel to the Central Exhaust Building.
  - d. Smoke Exhaust - Outside air will be brought in through the Linac smoke outside air fan and damper unit and the damper on the North wall of the Front End building or the two Ring Makeup air handlers. Linac tunnel air will be exhausted from the two Linac smoke exhaust fans and dampers. Ring tunnel air will be exhausted from the two Ring smoke exhaust fans and dampers.
- 6) Manual selection of each of these modes from the overview screens will be provided.
- 7) Under all conditions (whether or not controls for individual equipment is place in AUTO), receipt of PPS, ODH, or the fire alarm signals will cause equipment to be placed

in the appropriate tunnel operating mode. If multiple signals are received, the ODH and fire alarm signal will take precedence and place the tunnel in smoke exhaust mode.

- 8) The PPS system will provide two inputs – one for the Linac tunnel and one for the Ring Tunnel. This will cause operation as follows:
  - a. Receipt of the Linac tunnel signal will cause the Linac and HEBT tunnels to be placed in the Re-Circulation mode. Subsequent removal of this signal will not cause a mode change – this must be done manually.
  - b. Receipt of the Ring tunnel signal will cause the Ring and RTBT tunnels to be placed in the Re-Circulation mode. Subsequent removal of this signal will not cause a mode change – this must be done manually.
  - c. When the PPS signal is not present, the tunnel may be placed in ventilation mode manually from an EPICS screen.

Note: All logic relating the above signals to beam operation will be provided by the PPS system.

- 9) The ODH system will provide one input that will place the Linac tunnel in the Smoke Exhaust mode. No action will be taken for the Ring tunnel. Subsequent removal of this signal will change the Linac tunnel mode to Standby. Again, no action on the Ring tunnel. At this point, the logic will not allow the Linac tunnel mode to change in response to automatic action. (That is, changing to Re-Circulation or Ventilation mode requires manual action).
- 10) The Fire Alarm system will provide two inputs – one for the Linac tunnel and one for the Ring Tunnel. This will cause Linac and HEBT tunnels and the Ring and RTBT tunnels to operate as follows:
  - a. Receipt of the Fire Alarm signal or activating the smoke exhaust mode button on the operator screen will cause the affected tunnel to be placed in the Smoke Exhaust mode. No action will be taken on the unaffected tunnel.
  - b. Subsequent removal of this signal will change the affected tunnel mode to Standby. Again, no action on the unaffected tunnel. At this point, the logic will not allow the affected tunnel mode to change in response to automatic action. (That is, changing to Re-Circulation or Ventilation mode requires manual action).

Note: What this means is that once a tunnel is placed in the Smoke Exhaust mode, it must go through the Standby mode before it is manually placed in Re-Circulation or Ventilation.

Note: 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.

- 11) When a mode is manually selected, all the equipment in the tunnel will be placed in appropriate configurations simultaneously provided that:
  - a. Controls for the individual equipment or systems are placed in the AUTO mode
  - b. The Fire Alarm system signal calling for the smoke removal mode is not present
  - c. The PPS signal indicating a different configuration is needed is not present.

- 12) Temperature setpoints will not be automatically changed (such as between winter and summer). Manually changing the setpoints will be possible.
- 13) Tunnel operating modes will be selected manually only. There will be no "AUTO" mode where the logic will determine what operating mode will be used.
- 14) In the Smoke Exhaust mode, a time delay for heating the pre-heat coil and cooling the cooling coil before bringing the fan speed to setpoint should not be provided.
- 15) Freeze protection will be activated when appropriate temperatures fall below 40 degF and will consist of closing the outside damper, de-energizing air handler fans/dampers, and opening the heating valves to 25% open.
- 16) Common temperature, pressure, fan speed, and other setpoints for all equipment in the tunnels will not be provided on the two overview screens. They will be set by accessing individual equipment or system screens. The values of the setpoints will be displayed on the overview screen, but will not be changeable from the overview screen.

#### Operator Controls and Operating Modes

- 1) A mode switch with the four operating modes described above.

#### Digital Operator (EPICS) Controls

##### Control Mode

- 1) STANDBY
- 2) RE-CIRCULATION
- 3) VENTILATION
- 4) SMOKE EXHAUST – This button should be separated from the others, red in color, and clearly labeled as to be actuated on upon authorization. It is important that this switch not be actuated by mistake.

#### Analog Operator (EPICS) Controls

None as stated in 16 above.

#### Analog Displays

1. Air handler discharge temperatures
2. Return air temperatures
3. Tunnel temperatures
4. Air handler discharge flows
5. Linac and RTBT tunnel exhaust flows as indicated from flow measured at the Central Exhaust Building.
6. Pre-heat and cooling coil discharge air temperature setpoint
7. Return air temperature setpoint
8. Return air humidity setpoint
9. Tunnel air temperature setpoint
10. Fan speed setpoint (Ring only)

## Digital Displays

- 1) Mode switch status (Standby, Re-Circulation, Ventilation, Smoke Exhaust)
- 2) Actual tunnel configuration (Standby, Re-Circulation, Ventilation, Smoke Exhaust) – this will be the same as the mode switch unless the PPS or Fire Alarm signals are present. No attempt will be made to have the logic determine configuration from individual equipment measurements. It would be good to have this be a graphic display showing which fans/dampers and/or air handlers are active.
- 3) Fire Alarm Input (Smoke detector) status
- 4) PPS Input status
- 5) ODH Input status

Local Displays (field gauges only, no EPICS display) – Not Applicable

## Alarms

- 1) Receipt of Fire Alarm signal
- 2) Receipt of PPS signal
- 3) Receipt of ODH signal
- 4) Any Smoke removal fan/damper HOA switch not in AUTO position (there should be a graphical representation in addition to the alarm handler point to insure the operator notices that the switch is not in the desired position).

## **Control Logic States & Description**

### Control Logic Description

In all states, receipt of the ODH system signal will place the Linac tunnel in the Smoke Exhaust mode. No action will be taken for the Ring tunnel. Subsequent removal of this signal will change the Linac tunnel mode to Standby. Again, no action needed on the Ring tunnel. At this point, the logic will not allow the Linac tunnel mode to change in response to automatic action. (That is, changing to Re-Circulation or Ventilation mode requires manual action).

In all states, receipt of the smoke alarm signal from the fire alarm system signal will place the affected tunnel in the Smoke Exhaust mode. No action will be taken in the unaffected tunnel. Subsequent removal of these signals will change the affected tunnel mode to Standby. Again, no action needed on the unaffected tunnel. At this point, the logic will not allow the affected tunnel mode to change in response to automatic action. (That is, changing to Re-Circulation or Ventilation mode requires manual action).

In all states, receipt of the signal from the PPS system will place the tunnel in the Re-Circulation mode.

In all states, the fire alarm signal and ODH signals will take precedence over the PPS signal.

## **Standby**

- 1) Mode switch is in Standby.
- 2) All Air Handlers de-activated (fans de-energized and dampers closed or in re-circulation configuration– no outside air).
- 3) Smoke exhaust system de-activated (Fans de-energized, dampers closed).
- 4) Tunnel exhaust damper closed.

## **Re-Circulation**

- 1) Mode switch is in RE-CIRCULATION.
- 2) Linac Makeup Air Handler de-activated (fans de-energized and dampers closed). All other air handlers activated (fans/dampers energized controls active) in re-circulation mode – no outside air.
- 3) Smoke exhaust system de-activated (Fans de-energized, dampers closed).
- 4) Tunnel exhaust damper closed.

## **Ventilation**

- 1) Mode switch is in VENTILATION.
- 2) All air handlers activated (fans/dampers energized controls active) in ventilation mode – use outside air. Linac tunnel air handlers activated and controlling in an appropriate mode. Smoke exhaust system de-activated (Fans de-energized, dampers closed).
- 3) Tunnel exhaust damper open and primary exhaust fan energized.

## **Smoke Exhaust**

- 1) Mode switch is in SMOKE EXHAUST or fire alarm signal indicating smoke is present has been received.
- 2) Tunnel air handlers de-activated (OFF mode). Ring air handlers activated (fans/dampers energized controls active) in Smoke Exhaust mode.
- 3) Linac Makeup Air Handler and Smoke exhaust system activated (Fans energized and dampers open, damper on FE building North Wall open).
- 4) Tunnel exhaust damper closed.

