

9.4.13 Smoke Confinement System

The smoke confinement system (SCS) consists of several subsystems which operate to mitigate the effects of smoke or gases that could result from fire in the Nuclear Island (NI) buildings. The SCS functions in close coordination with the fire protection system. Refer to Section 9.5.1 for a description of the fire protection program. The SCS removes smoke from designated areas and maintains the emergency egress paths free of smoke. The SCS is normally switched off and remains in a standby mode for operation in the event of a fire.

The SCS is designed to protect rescue routes and staircases against the inflow of smoke from fire inside the adjacent rooms by supplying fresh outdoor air and pressurizing the rescue routes and staircases in relation to the adjacent rooms. In the event of a fire, the SCS depressurizes the rooms that contain a fire, and removes gases and smoke from these rooms. The gases and smoke are removed so that they do not enter other areas of the buildings through the normal ventilation system.

The SCS applies to the following areas and buildings of the NI:

- Safeguard Building (SB) divisions 1, 2, 3, and 4 (both mechanical and electrical areas, including SB divisions 2 and 3 interconnected passageways).
- Interconnected passageways and service corridors of SBs, Fuel Building, Nuclear Auxiliary Building, and Radioactive Waste Building.
- Fuel Building (FB).
- Nuclear Auxiliary Building (NAB).
- Access Building.
- Radioactive Waste Building (RWB).

The SCS is not required to operate during simultaneous events involving a potential release of radioactive contamination and fire. Airborne radioactivity is processed by the applicable building ventilation systems prior to release to the environment.

9.4.13.1 Design Bases

All components of the SCS are non-safety related and Non-Seismic, as specified in Section 3.2. The SCS performs no safety-related functions and is not required to operate during a design basis accident.

The SCS performs the following important non-safety-related system functions:

- Prevents smoke, hot gases, or fire suppressant agents from migrating from one area to another to the extent that they could adversely affect the safe-shutdown capabilities, including operator action. The environmental control systems are physically separated to satisfy these requirements, per SECY-90-016, Issue II.D (Reference 1).
- Protects access and egress pathways throughout the facility for habitability by maintaining higher pressure than adjacent areas to minimize smoke infiltration during a fire.
- Depressurizes and removes gases from the rooms with higher fire loads (e.g., electrical rooms). The SCS isolates these areas from the normal ventilation system by closing the fire dampers to confine the generated smoke and heat.
- Assists the fire brigade in rescue and fire fighting activities for fires in rooms with higher fire loads by creating a smoke-free layer for good visibility.
- Provides a minimum air renewal rate of 12 air changes per hour for the rooms to be exhausted by the smoke extraction subsystem.

9.4.13.2 System Description

9.4.13.2.1 General Description

In the event of a fire, the SCS is initiated either automatically through the plant fire alarm system signal or manually by the fire brigade. The system is designed to protect rescue routes and staircases against inflow of smoke from fire inside the adjacent rooms by supplying fresh outdoor air, pressurizing these areas in relation to adjacent rooms, and directing gases and smoke out of the buildings.

The SCS consists of the following subsystems:

- The staircases supply air subsystem.
- The supply and exhaust air subsystem for the interconnecting passageway between SB division 2 and division 3.
- The supply and exhaust air systems for the NI interconnecting passageway.
- The smoke extraction subsystem.

Staircases Supply Air Subsystem

The staircase supply air subsystem for each building operates independently. The staircase supply air and smoke extraction subsystem is shown in the typical configuration of the SCS provided in Figure 9.4.13-1—Typical Configuration of Smoke Confinement System.

The following lists the areas served:

- Staircases for SB electrical and mechanical divisions 1, 2, 3, and 4.
- Staircase between SB divisions 1 and 2.
- Staircase between SB divisions 3 and 4.
- FB staircase 1.
- FB staircase 2.
- NAB main staircase.
- NAB secondary staircase.
- Access Building southeast staircase.
- Access Building northwest staircase.
- RWB staircase 1.
- RWB staircase 2.

Each subsystem for the above areas consists of a fire-resistant concrete air intake ventilation chase with a motor-operated isolation damper and one 100 percent supply fan installed at the upper part of the staircase. The intake air openings have weather-protected grilles, and explosion pressure wave protective devices in FB and SBs only.

The air from the supply fan is directed through a galvanized steel ductwork to the bottom of the staircase. A fire damper on the duct separates the staircases into two different fire areas. A pressure control damper and motor-operated isolation damper installed on the exhaust ductwork provide pressure control in the staircases.

Fires in each area are isolated by fire dampers and fire walls. For the SBs, the supply air from stairways is directed through manual fire dampers to an anteroom, and then to the SB divisions 1, 2, 3 and 4 through individual fire dampers isolated by firewalls. The exhaust air from each area within the firewall is directed through individual fire dampers to the smoke extraction shaft.

Supply and Exhaust Air Subsystem for the Interconnecting Passageway between Safeguard Building Division 2 and Division 3

The interconnecting passageway between SB division 2 and division 3 is supplied with intake air through a fire-resistant concrete air intake ventilation chase with a motor-operated isolation damper and a supply fan. The intake air opening located at the top of the building has weather-protected grilles and explosion pressure wave protective devices. See Figure 9.4.13-2—Smoke Confinement System Interconnecting Passageway.

The air from the supply fan is directed through a galvanized steel ductwork to the bottom of the escape ladder shaft and to the interconnecting passageway.

A pressure control damper and motor-operated isolation damper installed on the exhaust ductwork provide pressure control in the interconnecting passageway and associated rooms. In case of fire in these areas, the smoke is extracted through the exhaust ductwork and directed outside of the building.

Supply and Exhaust Air Systems for the Nuclear Island Interconnecting Passageway

The intake air for the interconnecting passageway of the NI buildings is supplied by two fans installed in the heating, ventilating and air conditioning (HVAC) technical rooms of the SBs divisions 1 and 4 (see Figure 9.4.13-2). Each air intake duct includes a motor-operated isolation damper upstream of the fans. An outside bypass connection with a pressure control damper and an electric isolation damper is connected to the intake duct to control pressure in the rooms.

Supply and concrete exhaust air ventilation chases connect the interconnecting passageway of the NI buildings. Each designated area of the NI buildings is connected to the supply and exhaust ventilation chases through fire dampers which are normally closed, and opened by the plant fire alarm system in the event of a fire in the affected area. The exhaust ventilation chase connects to an exhaust air shaft through a pressure control damper. The exhaust air shaft connects to the exhaust air chamber in the NAB and then to the ventilation stack. The pressure control damper prevents air flow from the ventilation stack to the inside of the buildings.

Smoke Extraction Subsystem

The smoke extraction subsystem is designed to remove smoke from the rooms and interconnecting passageways of the SB divisions 1, 2, 3, and 4. The subsystem is shown on the typical configuration of the SCS provided in Figure 9.4.13-1. Air from the stairway supply subsystem is first received from the stairways to the anterooms through manual fire dampers, and subsequently to the SB divisions 1, 2, 3, and 4 through another set of manual fire dampers. The SB divisions include fire area compartments consisting of cable rooms, instrumentation and control (I&C) cabinets, switchgear, interconnecting passageways, and computer rooms. The exhaust air or gas from these fire area compartments is directed to the smoke extraction shaft through individual electrical fire dampers.

The exhaust gas or air is extracted through fire-resistant concrete ductwork by an exhaust fan and air check damper installed in the HVAC technical rooms of SB divisions 1, 2, 3, and 4. The electrical fire dampers located at each designated fire zone compartment are opened either automatically by the fire alarm system or manually by the fire brigade in the event of fire in that area.

9.4.13.2.2 Component Description

The major components of the SCS are listed in the following paragraphs.

Refer to Section 3.2 for the seismic and system quality group classification of these components.

Smoke Extraction Fans

The smoke extraction fans are centrifugal-type, directly coupled with electrical motors, statically and dynamically balanced, and thermally insulated.

Supply Air Fans

The supply air fans have an axial design with an electrical motor driver.

Isolation Dampers

Motorized bubble-tight dampers are used to isolate each exhaust and supply duct from outside air during normal plant operation (i.e., SCS not in operation).

Back Draft Dampers

Back draft dampers are used to isolate smoke exhaust ducts from outside air during normal plant operation (i.e., SCS not in operation). The dampers are bubble-tight and thermally insulated.

Fire Dampers

Fire dampers are installed where SCS ductwork penetrates a fire barrier. Fire damper design meets the requirements of UL 555 (Reference 2) and the damper fire rating is commensurate with the fire rating of the barrier penetrated.

Fire in a room is detected by the fire detection system, which automatically closes the associated fire dampers. These fire dampers are equipped with fusible links for automatic closure when the temperature reaches a predetermined setpoint. In addition, some fire dampers are motor-driven or manually actuated for closing and opening.

Pressure Control Dampers

Adjustable pressure relief dampers are used to limit and control overpressurization inside the staircase and interconnecting passageways.

Ducts

The SCS ventilation chases are made of fire-resistant concrete. The ductwork is made of galvanized steel.

9.4.13.2.3 System Operation

Normal Operating Conditions

The SCS is normally switched off and is in standby mode during normal plant operations. Only the systems or subsystems related to a specific area operate in the event of a fire in that area. The systems in that area are switched on either automatically by the plant fire alarm system or manually by the fire brigade. In addition, the plant fire brigade must open the associated manual fire dampers in order to target the air flow and exhaust to the impacted rooms. Other components or systems that are not associated with the area remain closed and in standby mode.

The SCS isolates the fire area, protects rescue routes and staircases against the inflow of smoke from fire inside the adjacent rooms, supplies fresh outdoor air, pressurizes the stairways and other fire zone areas to control spread of fire or smoke, and directs the exhaust gases and smoke out of the buildings.

Abnormal Operating Conditions

Plant abnormal operating conditions have no impact on the operation of SCS since the system is in standby mode and operates only in the event of a fire in a specific area. During a fire, the SCS provides habitable conditions for the fire brigade. Outside air intake and exhaust openings for the NI buildings are equipped with dampers that are normally closed. These dampers open during a fire in a specified fire area.

9.4.13.3 Safety Evaluation

The system is not required for the safe shutdown of the plant or for mitigating the consequences of a design basis accident; the system has no safety-related function.

The SCS fire dampers and smoke extraction fans are powered by a non-class 1E uninterruptible power supply (UPS) which allows the components to operate in the event of a loss of offsite power (LOOP). The balance of the system is powered by the normal power supply system.

9.4.13.4 Inspection and Testing Requirements

Refer to Section 14.2 (test abstract #085) for initial plant startup test program. Initial in-place acceptance testing of the SCS will be performed in accordance with NFPA 92A (Reference 3).

9.4.13.5 Instrumentation Requirements

The plant fire alarm system controls electrical components of the SCS. Indication of the operational status of the equipment is provided in the main control room (MCR).

9.4.13.6 References

1. SECY-90-016, "Evolutionary LWR Certification Issues and Their Relationship to Current Regulatory Requirements," U.S. Nuclear Regulatory Commission, January 1990.
2. UL 555, "Standard for Fire Dampers," Underwriter's Laboratories, Sixth Edition, June 1999.
3. NFPA 92A (06), "Recommended Practice for Smoke-Control Systems," National Fire Protection Association, 2006.