9.0 AUXILIARY AND EMERGENCY SYSTEMS

9.8 FACILITY SERVICE SYSTEMS

The Facility Service Systems consist of the Fire Protection Systems, the Service Water System, and the Compressed Air System.

9.8.1 Fire Protection

The fire protection program is based on the NRC requirements and guidelines, Nuclear Electric Insurance Limited (NEIL) Property Loss Prevention Standards and related industry standards. With regard to NRC criteria, the fire protection program meets the requirements of 10 CFR 50.48(c), which endorses, with exceptions, the National Fire Protection Association's (NFPA) 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition. Donald C. Cook Nuclear Power Plant (CNP) has further used the guidance of NEI 04- 02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program under 10 CFR 50.48(c)," as endorsed by Regulatory Guide 1.205, "Risk-Informed, Performance Fire Protection for Existing Light-Water Nuclear Power Plants."

Adoption of NFPA 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, in accordance with 10 CFR 50.48(c), serves as the method of satisfying 10 CFR 50.48(a) and General Design Criterion 3. Prior to adoption of NFPA 805, General Design Criterion 3, "Fire Protection," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," was followed in the design of safety and non-safety related structures, systems, and components, as required by 10 CFR 50.48(a).

NFPA 805 does not supersede the requirements of GDC 3, 10 CFR 50.48(a), or 10 CFR 50.48(f). Those regulatory requirements continue to apply. However, under NFPA 805, the means by which GDC 3 or 10 CFR 50.48(a) requirements are met may be different than under 10 CFR 50.48(b). Specifically, whereas GDC 3 refers to SSCs important to safety, NFPA 805 identifies fire protection systems and features required to meet the Chapter 1 performance criteria through the methodology in Chapter 4 of NFPA 805. Also, under NFPA 805, the 10 CFR 50.48(a)(2)(iii) requirement to limit fire damage to SSCs important to safety so that the capability to safely shut down the plant is satisfied by meeting the performance criteria in Section 1.5.1 of NFPA 805.

A Safety Evaluation was issued on October 24, 2013 by the NRC, that transitioned the existing fire protection program to a risk-informed, performance-based program based on NFPA 805, in accordance with 10 CFR 50.48(c).

9.8.1.1 Design Basis Summary

9.8.1.1.1 Defense-in-Depth

The fire protection program is focused on protecting the safety of the public, the environment and plant personnel from a plant fire and its potential effect on safe reactor operations. The fire protection program is based on the concept of defense-in-depth. Defense-in-depth shall be achieved when an adequate balance of each of the following elements is provided:

1. Preventing fires from starting,
2. Rapidly detecting fires and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage,
3. Providing an adequate level of fire protection for structures, systems, and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed.

9.8.1.1.2 NFPA 805 Performance Criteria

The design basis for the fire protection program is based on the following nuclear safety and radiological release performance criteria contained in Section 1.5 of NFPA 805:

1. Nuclear Safety Performance Criteria: Fire protection features shall be capable of providing reasonable assurance that, in the event of a fire, the plant is not placed in an unrecoverable condition. To demonstrate this, the following performance criteria shall be met.
   a. Reactivity Control: Reactivity control shall be capable of inserting negative reactivity to achieve and maintain subcritical conditions. Negative reactivity inserting shall occur rapidly enough such that fuel design limits are not exceeded.
   b. Inventory and Pressure Control: With fuel in the reactor vessel, head on and tensioned, inventory and pressure control shall be capable of controlling coolant level such that subcooling is maintained such that fuel clad damage as a result of a fire is prevented for a PWR.

   c. Decay Heat Removal: Decay heat removal shall be capable of removing sufficient heat from the reactor core or spent fuel such that fuel is maintained in a safe and stable condition.

   d. Vital Auxiliaries: Vital auxiliaries shall be capable of providing the necessary auxiliary support equipment and systems to assure that the systems required under (a), (b), (c), and (e) are capable of performing their required nuclear safety function.

   e. Process Monitoring: Process monitoring shall be capable of providing the necessary indication to assure the criteria addressed in (a) through (d) have been achieved and are being maintained.

2. Radioactive Release Performance Criteria: Radiation release to any unrestricted area due to the direct effects of fire suppression activities (but not involving fuel damage) shall be as low as reasonably achievable and shall not exceed applicable 10 CFR, Part 20, Limits.

Chapter 2 of NFPA 805 establishes the process for demonstrating compliance with NFPA 805.

Chapter 3 of NFPA 805 contains the fundamental elements of the fire protection program and specifies the minimum design requirements for fire protection systems and features.

Chapter 4 of NFPA 805 establishes the methodology to determine the fire protection systems and features required to achieve the nuclear safety performance criteria outlined above. The methodology shall be permitted to be either deterministic or performance-based. Deterministic requirements shall be “deemed to satisfy” the performance criteria, defense-in-depth, and safety margin and require no further engineering analysis. Once a determination has been made that a fire protection system or feature is required to achieve the nuclear safety performance criteria of Section 1.5, its design and qualification shall meet the applicable requirement of Chapter 3.

9.8.1.1.3 Codes of Record

The codes, standards and guidelines used for the design and installation of plant fire protection systems are as follows: (for specific applications and evaluations of codes refer to Engineering Equivalency Evaluation 14.1.1, “NFPA Code Conformance Report”).

- NFPA 10 – 1984, “Standard for Portable Fire Extinguishers”
- NFPA 12 – 1968, 2005, “Standard on Carbon Dioxide Extinguishing Systems”

- NFPA 12A – 1977, "Standard on Halon 1301 Fire Extinguishing Systems"
- NFPA 13 – 1971, 1983, 1991, "Standard for Installation of Sprinkler Systems"
- NFPA 14 – 1971, 1978, 1986, 1990, "Standard for the Installation of Standpipe, Private Hydrant and Hose Systems"
- NFPA 15 – 1973, "Standard for Water Spray Fixed Systems for Fire Protection"
- NFPA 20 – 1990, "Standard for the Installation of Stationary Pumps for Fire Protection"
- NFPA 22 – 1987, "Standard for Water Tanks for Private Fire Protection"
- NFPA 24 – 1987, "Standard for the Installation of Private Fire Service Mains and their Appurtenances"
- NFPA 30 – 1987, "Flammable and Combustible Liquids Code"
- NFPA 50A – 1999, "Standard for Gaseous Hydrogen Systems at Consumer Site"
- NFPA 51B – 1971, "Standard for Fire Prevention During Welding, Cutting, and Other Hot Work"
- NFPA 72D – 1967, 1979, "Installation, Maintenance, and Use of Proprietary Protective Signaling Systems"
- NFPA 72E – 1974, 1978, 1982, 1984, "Automatic Fire Detectors"
- NFPA 80 – 1970, "Standard for Fire Doors and Fire Windows"
- NFPA 80A – 1996, "Recommended Practice for Protection of Buildings for Exterior Fire Exposures"
- NFPA 90A – 1978, "Standard for the Installation of Air-Conditioning and Ventilation Systems"
- NFPA 101 – Current Edition, "Life Safety Code"
- NFPA 220 – 1999, "Standard on Types of Building Construction"
- NFPA 241 – 2000, "Standard for Safeguarding Construction, Alterations, and Demolition Operations"

- NFPA 251 – 1999, "Standard Methods of Fire Tests of Fire Endurance of Building Construction and Materials"
- NFPA 256 – 1998, "Standard Methods of Fire Tests of Roof Coverings"
- NFPA 600 – 2000, "Standard on Industrial Fire Brigades"
- NFPA 701 – 1999, "Standard Methods of Fire Tests for Flame Propagation of Textiles and Films"

9.8.1.2 System Description

9.8.1.2.1 Required Systems

Nuclear Safety Capability Systems, Equipment and Cables

Section 2.4.2 of NFPA 805 defines the methodology for performing the nuclear safety capability assessment. The systems equipment and cables required for the nuclear safety capability assessment are contained in the "Nuclear Safety Capability Assessment" (NSCA).

Fire Protection Systems and Features

Chapter 3 of NFPA 805 contains the fundamental elements of the fire protection program and specifies the minimum design requirements for fire protection systems and features. Compliance with Chapter 3 is documented in the "NFPA 805 Fire Protection Program Manual" (NFPPM).

Chapter 4 of NFPA 805 establishes the methodology and criteria to determine the fire protection systems and features required to achieve the nuclear safety performance criteria of Section 1.5 of NFPA 805. These fire protection systems and features shall meet the applicable requirements of NFPA 805 Chapter 3. These fire protection systems and features are documented in the "D. C. Cook Fire Safety Analysis" (FSA).

The Fire Protection System is shown in Figures 9.8-1 and 9.8-2.

Radioactive Release

Structures, systems, and components relied upon to meet the radioactive release criteria are documented in the "NFPA 805 Fire Protection Program Manual" (NFPPM).

9.8.1.2.2 Definition of "Power Block" Structures

Where used in NFPA 805 Chapter 3 the terms "Power Block" and "Plant" refer to structures that have equipment required for nuclear plant operations. For the purposes of establishing the structures included in the fire protection program in accordance with 10 CFR 50.48(c) and NFPA

805, the plant structures listed in Table 9.8-1 are considered to be part of the "power block" as identified in the NRC NFPA 805 Safety Evaluation, dated October 24, 2013.

9.8.1.3 Safety Evaluation

The "D. C. Cook Fire Safety Analysis" (FSA) documents the achievement of the nuclear safety and radioactive release performance criteria of NFPA 805 as required by 10 CFR 50.48(c). This document fulfills the requirements of Section 2.7.1.2, "Fire Protection Program Design Basis Document," of NFPA 805. The document contains the following:

- Identification of significant fire hazards in the fire area. This is based on NFPA 805 approach to analyze the plant from an ignition source and fuel package perspective.
- Summary of the Nuclear Safety Capability Assessment (at power and non-power) compliance strategies.
  - Deterministic compliance strategies
  - Performance-based compliance strategies (including defense-in-depth and safety margin)
- Summary of the Non-Power Operations Modes compliance strategies.
- Summary of the Radioactive Release compliance strategies.
- Summary of the Fire Probabilistic Risk Assessments.
- Key analysis assumptions to be included in the NFPA 805 monitoring program.

9.8.1.4 Fire Protection Documentation, Configuration Control and Quality Assurance

In accordance with Chapter 3 of NFPA 805 a fire protection plan documented in Procedure PMI-2270, "Fire Protection Program," defines the management policy and program direction and defines the responsibilities of those individuals responsible for the plan's implementation. Procedure PMI-2270:

- Designates the senior management position with immediate authority and responsibility for the fire protection program.
- Designates a position responsible for the daily administration and coordination of the fire protection program and its implementation.

- Defines the fire protection interfaces with other organizations and assigns responsibilities for the coordination of activities. In addition, Procedure PMI-2270, "Fire Protection Program," identifies the various plant positions having the authority for implementing the various areas of the fire protection program.
- Identifies the appropriate authority having jurisdiction for the various areas of the fire protection program.
- Identifies the procedures established for the implementation of the fire protection program, including the post-transition change process and the fire protection monitoring program.
- Identifies the qualifications required for various fire protection program personnel.
- Identifies the quality requirements of Chapter 2 of NFPA 805.

Detailed compliance with the programmatic requirements of Chapters 2 and 3 of NFPA 805 is contained in the "NFPA 805 Fire Protection Program Manual" (NFPPM).

9.8.2 Compressed Air System

The Compressed Air System is shown on Figure 9.8-3.

9.8.2.1 Design Bases

Parameters included in design:

1. The system must provide redundant compressed air supplies for control and instrument air requirements.
2. The system must provide adequate compressed air capacity for:
   a. General Plant Service
   b. Control
   c. Instrumentation
   d. Testing
   e. Containment Penetration and Weld Channel Pressurization System
   f. Respiratory protection in the containment structure itself, as per compressed gas association commodity Spec. G-7.1 - 1966, per OSHA Standards and Interpretations 1910.134.
3. The system must provide a continuous supply of compressed air to vital systems under both normal and abnormal conditions.

9.8.2.2 System Description

The Compressed Air System includes the combined service and control instrument air sub-systems, the air supply for the Containment Penetration and Weld Channel Pressurization System and air respiratory protection at strategic location. Either of the two full capacity plant air compressors, one located in the turbine building of each unit, is capable of supplying compressed air to the plant air receivers for general service air for both units. In addition, the plant air compressors supply air to the dry control-instrument air receivers through redundant pre- and after-filters and dryers.

The Containment Penetration and Weld Channel Pressurization System air receivers are supplied from these dry control-instrument air receivers.

In addition, a standby control air compressor capable of supplying the control and instrument air for its unit is installed as a backup for the normal control-instrument air supply, i.e., the plant air compressors. This standby compressor is also capable of supplying air to the Containment Penetration and Weld Channel Pressurization System for its unit. The standby control air compressor is designed to start automatically upon detection of low air pressure in the plant air header.

The four air compressors (two plant, two control) are of the oil-free type to eliminate oil contamination of the control instrument air. Control and instrument air is also filtered and dried to remove any particulate matter and/or moisture which could interfere with the operation of any instrumentation and control equipment.

The Control Air System includes sufficient capacity to supply the control and instrument air requirements with the equivalent of approximately 5 minutes of control air output after a loss of power incident. Additionally, certain vital control valves within the containment are each equipped with a local receiver tank with capacity to activate the valve. Also, the control air compressors can be supplied with electric power from both normal and emergency sources so that a supply of compressed air can be made available in any foreseeable circumstance.

The Compressed Air System includes normal accessory equipment such as dryers, filters, storage receivers, after-coolers, and safety valves in addition to the compressors. A descriptive summary of the major pieces of equipment in the system is included in Table 9.8-2.

In addition, a 650CFM backup plant air compressor is installed on the Unit # 1 4KV Switchgear Room roof. The backup plant air compressor is tied into the normal plant compressed air system at both the inlet and outlet of the Containment Test Pressurization Air Dryer and can supply any service air or control instrument air load. The compressor must be manually started and aligned. The 575 V, 150 Amp power supply is provided from 600V Bus 11CMC.

9.8.2.3 Design Evaluation

The Compressed Air System is designed to provide a reliable source of compressed air for all plant uses.

During normal operation, either one of the two plant air compressors is capable of supplying the entire demand of both plant and control-instrument air requirements for both units.

Low plant air header pressure will automatically start the second plant air compressor. The air compressor is then manually loaded and placed in automatic pressure control. A lower control air header pressure in either unit will automatically start that unit's control air compressor. A further degradation in the plant air header pressure will cause the four air-operated isolation valves located in the plant air ring header to close, thus completely isolating the control air systems of the two units.

This system arrangement allows either unit's plant air system to be removed from service should that become necessary while allowing the remainder of the plant air system as well as both unit's control air system to continue in operation. This isolation can be achieved by closing the two air-operated isolation valves, which serve the effected unit.

In this manner, each unit still retains a backup supply of compressed air from its own control air compressor.

A failure in the control air system of one unit will not affect the control air system of the other unit because check valves in the control air off-takes from the plant air header prevent back flow.

Each control air header has safety relief valves to protect against over-pressurization.

9.8.2.4 Tests and Inspections

The compressed air systems is in service during all modes of operation. Flow and pressure instrumentation for the plant air system, and the control air system permit monitoring the systems for excessive air consumption, or inadequate compressor capacity.

Tests and inspections include:

- Routine functional testing of the standby plant and control air compressors, to ensure their readiness.
- Routine compressor inspections /overhauls.
- Routine prefilter, dryer desiccant, and after filter inspection/replacement.
- Routine air quality monitoring for moisture, and breathing air quality.

9.8.3 Service Water Systems

The Service Water Systems are shared by both units.

9.8.3.1 Design Basis

The Service Water Systems supply cooling water to various heat exchangers in both the primary and secondary systems of each unit. Provisions are made to ensure a continuous flow of cooling water to those systems and components necessary for plant safety both during normal operation or under accident conditions. Sufficient redundancy of piping and components is provided to insure that cooling is maintained to vital services at all times.

9.8.3.2 Description

Service water is provided by two independent systems, the Non-Essential Service Water System shown in Figures 9.8-4, 9.8-5 and 9.8-6 and the Essential Service Water System shown in Figure 9.8-7. Each system consists of four operational pumps, each with a duplex automatic backwashing strainer in its discharge line, and associated piping and valves. The design parameters of these components are listed in Table 9.8-3.

Non-Essential Service Water System

The Non-Essential Service Water System (NESW) supplies cooling water to the following SSCs. Turbine oil coolers, air compressors, chilled water subsystem and miscellaneous services, none of which are required for plant safety related functions. The chilled water subsystem provides cooling to the Upper and Lower Containment Ventilation Units, Instrument Room Ventilation Units, and Reactor Coolant Pump Motor Air Coolers. The NESW also provides an alternate source of water to equipment served by the Miscellaneous Sealing and Cooling Water (MSCW) System when the MSCW System is being serviced and/or operational. Cooling requirements are given in Table 9.8-4, Table 9.8-4A, and Table 9.8-4B. The number of main pumps normally operated to provide service water to the two units is dependent upon system flow demands. Typically, 2 or 3 main pumps are in service with at least one pump held in standby. All main pumps are able to take suction from either the Unit 1 or Unit 2 Circulating Water Intake Tunnels or discharge tunnels. The system discharges into either the Unit 1 or Unit 2 Circulating Water Discharge Tunnels. Thus, Non-Essential Service Water supply to both units is assured, even if the tunnels of one unit are out of service.

Following a loss of all off-site power, the non-essential service water main pumps are automatically started in the proper sequence as soon as the emergency diesel generator power becomes available. Under those conditions, the main pumps are primarily used to supply cooling water to the control air compressors in order to restore control air service. All motor-operated valves on the main non-essential water system are operated from the station battery system with the exception of the inlet and outlet valve motor operators for each of the main NESW duplex strainers, which are powered from the 600 VAC auxiliary bus. Crossties between the main pumps permit any one main pump to supply the initial requirements for both units upon loss of off-site power (LOOP).

The discharge strainers of the pumps are of duplex construction, with automatic backwashing. Each strainer is effectively two strainers in one casing with flow directed through one half, while slide gates block off the other half. When the strainer is in service and if it becomes dirty or clogged, a high differential pressure signal initiates a shift of the slide gates blocking the flow to the dirty basket and directing it through the clean basket. The dirty basket is then backwashed and is ready for re-use.

Containment Chilled Water Subsystem

The Containment Chilled Water Subsystem consists of a closed-loop chilled water system and an open-loop condenser cooling system. The system consists of three water-cooled chillers per unit. Cooling water will be circulated through the Upper and Lower Containment Ventilation Units, Instrument Room Ventilation Units, Reactor Coolant Pump Motor Air Coolers, and through part of the new cooling system creating a closed loop. NESW will flow from the intake tunnel through the new cooling system and into the discharge tunnel, creating an open loop. Heat will be transferred from the closed loop via a chiller (evaporator and condenser) and/or a heat exchanger to the open loop NESW.

Alternately, direct cooling of the containment air handling units via the NESW can still be implemented if the chilled water subsystem is unable to operate.

Essential Service Water System

The Essential Service Water (ESW) System supplies cooling water to the following components:

a. Component Cooling Heat Exchangers

b. Containment Spray Heat Exchangers

c. Emergency Diesel Generators

d. Auxiliary Feedwater System

e. Control Room Air Conditioners

f. Auxiliary Feedwater Pump Enclosure Coolers

During normal operations essential service water is supplied continuously to the Component Cooling Heat Exchangers and the Control Room Air Conditioners. The Containment Spray Heat Exchangers and the Emergency Diesel Generators are normally supplied only when these systems are in operation. The Essential Service Water may be manually aligned to the diesel generators to help in establishing minimum flow requirements. In addition, the essential service water system serves as back-up water sources to the auxiliary feedwater pumps for use when the condensate storage tank, the normal supply for the auxiliary feed-water system, is either empty or otherwise lost as a source of supply.

The system consists of four essential service water pumps, four duplex strainers and associated piping and valves. System piping is arranged in two independent headers, each serving certain components in each unit as follows:

a. Each essential service water header supplies cooling water to one of the two Containment Spray Heat Exchangers associated with each unit.

b. The heat exchangers for the two diesel-generator sets on each unit are served by the respective essential service water header on that unit. Remotely-operated valves are provided to supply each diesel with ESW from the redundant header for beyond-design-basis events.

c. Each essential service water header supplies cooling water to one of the two Component Cooling Heat Exchangers associated with each unit.

d. In each unit one essential service water system provides the source of feedwater for the turbine-driven auxiliary feedwater pump and the other to both motor-driven auxiliary feed pumps.

e. Each essential service water header supplies cooling water to one of the two Control Room Air Conditioners associated with each unit.

f. Each essential service water header supplies cooling water to two of the Auxiliary Feedwater Pump Enclosure Coolers.

The two headers are arranged such that a rupture in either header will not jeopardize the safety functions of the system. Each header is served by two essential service water pumps. Two pumps are sufficient to supply all service water requirements for unit operation, shutdown, refueling or post-accident operation, including a LOCA on one unit and a simultaneous hot shutdown in the other. System conditions will dictate when a third pump is required such as when CCW system heat load is high due to RHR system operation. All pumps receive a start signal in the event of an accident.

The pump discharge strainer backwash valves are provided with a backup control air source to support strainer backwash should the normal control air source become unavailable.

Since the thermal load on the Component Cooling Water Heat Exchangers is reduced after a safety injection signal, the Essential Service Water flow to these heat exchangers is automatically reduced to insure adequate flow to the Containment Spray Heat Exchangers if needed. Flow is automatically supplied to the Containment Spray Heat Exchangers during the recirculation mode if a containment spray signal has been initiated. Upon receipt of a Phase B isolation signal, full ESW design flow is established to both Containment Spray Heat Exchangers. The header and valving arrangement insures adequate service water flow under all normal and emergency conditions.

Table 9.8-5 contains data for ESW cooling flows under normal operation, cooldown, LOCA Injection and LOCA Recirculation conditions.

Normal Operation & Cooldown

The values in Table 9.8-5 for Normal Operation and Cooldown represent nominal flow conditions required to support normal operation of the plant within the current licensing basis. Values for component flows used in the plant are adjusted to include uncertainty and will depend upon the actual operating condition.

LOCA Injection & LOCA Recirculation

The Table 9.8-5 data for LOCA injection and recirculation is the minimum ESW cooling flow required for accident response and mitigation, using plant emergency operating procedures. During LOCA Injection, there is minimal heat load on the CCW system. The CCW flow is provided to the RHR heat exchanger during injection to provide a minimum flow path for the CCW pump. There is no RHR heat load on CCW during LOCA injection.

The values in Table 9.8-5 are the minimum flows to systems, required to meet the accident mitigation strategy in the accident analyses supporting the current licensing basis. Values for component flows used in the plant are adjusted to include uncertainty.

The Essential Service Water Pumps take suction from a separate section of the screenhouse, which cannot be isolated from the lake. As described in Sub-Chapter 10.6, lake water is supplied to the screenhouse forebay by three 16 foot diameter pipes which terminate approximately 2250 feet from shore. It is inconceivable that damage from barge or ship accidents or even natural phenomena could totally isolate these three pipes; however, motor operated sluice gates which normally separate the discharge from the intake can be opened providing another access to the lake. Furthermore, the maximum demand for the ESW system is only slightly more than one percent of the total circulating water system during normal operation.

The pumps are designed to operate as Class I equipment, with the motor drives located above the maximum flood level. The pump motors can be supplied with power from normal or emergency sources, thereby insuring a continuous flow of service water under all conditions.

Small ESW System leaks in the Auxiliary Building drain to the various Auxiliary Building sumps. A Sump High Level alarm will alert the operator to an increasing water level in the corresponding sump. Visual inspection performed by the operator will determine the source of the leak.

Large leaks in the ESW System will initiate alarms associated with one or more of the following: Low Header Pressure, High Pipe Tunnel Sump level, or High Auxiliary Building Sump Level. Any one of these alarms will alert the operator to a probable ESW pipe rupture. In addition, flow indicators are located in the ESW supply headers and in the supply lines to each Component Cooling and Containment Spray Heat Exchanger as well as each Diesel Generator return header. The header supply valves are remotely operated to enable isolation of the supply header or pump that has failed.

Radiation alarms monitor the Essential Service Water discharge for potential inleakage of radioactive liquid. Such inleakage is unlikely but is postulated to occur due to tube leaks in the containment spray heat exchangers during their use.

9.8.3.3 Design Evaluation

Non-Essential Service Water System

The Non-Essential Service Water System is not required for the maintenance of plant safety related functions in the event of an accident. During normal operation, the system remains functional even if one Unit is out of service and its circulating water tunnels are dewatered.

Essential Service Water System

The Essential Service Water System is designed to prevent any failure in its system from curtailing normal plant operation or limiting the ability of the engineered safeguards to perform their functions in the event of an accident. Since the Essential Service Water System is required for long term heat removal, it is designed to withstand a passive failure on a long term basis. Sufficient pump capacity is included to provide design service water flow under all postulated conditions. The headers are arranged such that even loss of a complete header does not jeopardize plant safety related functions. Table 9.8-6 gives a malfunction analysis of a pump, valve and strainer.

9.8.3.4 Tests and Inspections

System components were hydrostatically tested prior to station startup and are accessible for periodic inspections or tests during operation. Electrical components, switchovers, and starting controls are tested periodically.

The essential service water pumps and certain valves are tested in accordance with the applicable edition of the ASME Operation and Maintenance (OM) Code. Periodic testing of the non-essential service water pumps is conducted in accordance with normal industry practice.

9.9 AUXILIARY BUILDING VENTILATION SYSTEM

9.9.1 General Description

The auxiliary building ventilation systems, shown in Figures 9.9-1 and 9.9-2, consist of:

a. Engineered Safety Features Ventilation System (one per plant unit).

b. Fuel Handling Area Ventilation System (one shared system).

c. General Ventilation Systems (one per plant unit with crosstie).

d. General Supply System (one per plant unit).

The auxiliary building is basically a five-level compartmented structure containing the auxiliary nuclear equipment for both units. All equipment handling radioactive fluids is located on the lower four levels of the auxiliary building. The fourth level also houses the two control rooms and the ventilation equipment.

The auxiliary building ventilation systems are designed to maintain temperatures in the various portions of the building within design limits for operation of equipment and for personnel access for inspection, maintenance and testing as required.

9.9.2 Design Bases

Outside ambient conditions used for design purposes are 91°F summer dry bulb, 75°F summer wet bulb and -7°F winter dry bulb. Ventilation is based on limiting temperatures to a maximum design calculated for each area. Heating is provided to maintain a 60°F minimum temperature.

General ventilation systems serving the auxiliary building are once-through systems. Supply air is introduced to the areas least likely to be contaminated, and exhausted directly from those with the greatest contamination potential. Additionally, the exhaust systems are of greater capacity than the supply systems, thus maintaining the area within the auxiliary building pressure boundary at a slightly negative pressure. The auxiliary building pressure boundary is the area within the auxiliary building, which is maintained at a negative pressure by the HVAC system, as required for radiological control.

All exhaust air from the auxiliary building is directed to the unit vents. There is a vent for each unit. Each vent has radiation detectors for continuous monitoring of the exhaust air during release to atmosphere.

High efficiency particulate air filter cells are designed to remove as little as 99 percent of particulates. Performance characteristics of the charcoal adsorbers provide for removal of as little as 94.05 percent of methyl iodide, which includes a minimum charcoal filter efficiency of 95 percent and a maximum bypass leakage of one percent. Supply and exhaust unit roughing filters have a NBS duct spot efficiency (Cottrell Precipitate) of 75%.

9.9.3 System Descriptions

9.9.3.1 Engineered Safety Features Ventilation

The enclosures for the engineered safety features equipment for both units are located in the lower three levels of the auxiliary building. (The containment spray heat exchanger and residual heat exchanger enclosures extend up into the fourth level with access into the enclosures from the third level only.) The enclosures for each unit's safety feature equipment are ventilated by two separate ventilation systems. The areas serviced by this system are: the containment spray pump enclosures, the residual heat removal pump enclosures, the safety injection pump enclosures, the residual heat exchanger enclosures, the containment spray heat exchanger enclosures and the reciprocating and centrifugal charging pump enclosures. Figure 9.9-2 shows a flow diagram of the engineered safety features ventilation system and is typical for the system serving either unit.

The exhaust ventilation system is composed of two 25,000 cfm fan/ filter exhaust units (1 standby) which draw air from the auxiliary building through the equipment enclosures via a common vent shaft and discharge it to the unit vent. Each fan/filter unit is composed of a 100% capacity bank of roll media roughing filters, high efficiency particulate air filters, charcoal filters and a 100% capacity exhaust fan. (There is a bypass on the charcoal filter bank.) This is a Class I ventilation system, therefore each fan/filter unit receives power from a separate engineered safeguards system bus which can be fed from the diesel bus and all components up to the connection to the unit vent are of Class I design.

Normally, one fan/filter unit operates continuously, directing the exhaust air through the roughing filter and high efficiency particulate air filter, bypassing the charcoal filter, and discharging it to the unit vent. This operation aids in the air distribution within the auxiliary building, isolates the atmosphere in the enclosures by inducing a draft through the entering portals and removes any heat generated within the enclosures.

In the event of a Phase B Isolation signal the charcoal filter bypasses are automatically closed and the air is directed through the charcoal filters in addition to the roughing and high efficiency particulate air filters. There are two independent air operated, fail-closed, dampers in the charcoal filter bypass. These dampers are arranged in parallel. The charcoal filters can be placed in service when gaseous contamination warrants their operation. The standby fan unit starts on any train related ESF system pump start signal, or upon receipt of a safety injection signal.

Make-up air for the Engineered Safety Features Ventilation System is normally provided by the Auxiliary Building general supply. Partial make-up air can be provided during a loss of off-site power by three 15,000 cfm fans blowing outdoor air into the component cooling pump area of the Auxiliary Building (third level). The fans are Class I design and are provided for use in emergency conditions.

Power for two of the 15,000 cfm fans can be provided by the Unit No. 1 diesel-generators, and for the third by Unit No. 2 diesel-generators.

These fans are dual purpose during an emergency, aiding in providing safe ambient temperature for the component cooling pump motors and providing partial make-up air for the engineered safety features ventilation system. The capacity of these fans is less than the engineered safety features ventilation system exhaust fans, thus ensuring a negative pressure within the auxiliary building pressure boundary during an emergency.

In addition to the engineered safety features ventilation system described above, the emergency diesel-generator rooms, essential service water pump enclosures, safety related battery rooms, and the electric relay rooms are ventilated by systems powered by the emergency diesels. These systems include supply and/or exhaust fans sized to maintain design ambient temperatures within the various rooms and enclosures. The Auxiliary Feedwater Pump Enclosure coolers, which are designed to maintain design ambient temperatures, receive cooling water from redundant ESW headers, and are powered by the emergency diesels.

9.9.3.2 Fuel Handling Area Ventilation System

The fuel handling area is a shared facility and its ventilation system is therefore a shared facility consisting of an exhaust system and a supply system.

The fuel handling area exhaust system is composed of two 30,000 cfm fans (1 standby) which draw air through a common slot exhaust plenum along the north side of the spent fuel pool to direct it through a filter housing and discharge it to the unit No. 1 vent. The filter assembly is composed of roll media roughing filters, high efficiency particulate air filters and charcoal filters. There is a normally open bypass on the charcoal filters.

The Fuel Handling Area Supply Air System is made up of four supply units composed of fans, filters and steam coils. Two 11,000 cfm supply units are located in the western section of the Fuel Handling Area and two 2,500 cfm supply units are located in the eastern section of the Fuel Handling Area. Normally, all four supply units operate, drawing outside air through the steam coils and filters and discharging it into the fuel handling area. The air is drawn through the Fuel Handling Area into the exhaust plenum, and passed through the roughing and high efficiency particulate air filters by a continuously operating exhaust fan and discharged into the unit No. l vent. The combined capacity of the four supply units is less than that of a single exhaust fan, thus the Fuel Handling Area, as well as the entire space within the auxiliary building pressure boundary, are maintained at a slightly negative pressure.

In the event that the area radiation monitors in the Fuel Handling Area give a high radiation signal the charcoal filter bypass dampers are tripped closed thus passing the exhaust air through the charcoal filters prior to discharge to the vent. This system can also be manually aligned through the charcoal filters. Since the area radiation monitors in the Fuel Handling Area do not actuate on a high radiation signal fast enough in the event of a Fuel Handling Accident in the Auxiliary Building to preclude the discharge of radioactive gases to the Unit 1 vent, a charcoal filter in the Fuel Handling Area Ventilation System is manually placed in service prior to irradiated fuel movement. A charcoal filter is also manually placed in service prior to crane operation with non-fuel loads over the Spent Fuel Pool. The Fuel Handling Area Supply Units are also tripped on the high radiation signal, thus ensuring a negative pressure within the space.

Operation of this system is the same for both summer and winter conditions. During winter operation the heating capacity of the supply units is supplemented by steam unit heaters located throughout the Fuel Handling Area.

9.9.3.3 General Ventilation System

All areas except the fuel handling area and the safeguard equipment areas are exhausted in each unit by a ventilation system consisting of two 50% capacity fans with roughing and high efficiency particulate air filters. There is no standby capacity in these systems, however there is a normally closed tie-line between the Unit No. 1 and Unit No. 2 exhaust units.

Normally, all fans operate at their design speed and direct their air flow through the filters and then to the unit vent. This operation induces a draft of 50 to 150 fpm through the entrance portals of the various enclosures thus removing any heat, vapors or particulate matter generated within the enclosures.

The hot laboratory chemical hood and cabinet exhaust fans, sample room sink hood and sample rack exhaust fans also discharge into this system. In the event of a high radiation signal from the vent monitor, the gas decay tank discharge is automatically closed.

The hot laboratory is located in the access control area of the Auxiliary Building. The access control area includes a radiation control office, a radiation protection supervisor's office, a chemical foreman's office, and other miscellaneous rooms which have no internal contamination potential, and a hot laboratory, chemical counting room, and R. P. counting room and decontamination area which are in a potential contamination area. The clean, or non-contaminated rooms are air-conditioned by a conventional, partial recirculation system which also pressurizes these areas. The potentially contaminated areas are air-conditioned by a once-through system with 100% fresh air supply of conditioned air, which is exhausted to the auxiliary building general exhaust system.

The spray additive tank room houses the post-accident sampling system panel and is normally ventilated by the auxiliary building general exhaust system. When necessary, the spray additive tank room can be isolated from the auxiliary building general exhaust system and ventilated by the spray additive tank room filter unit and the spray additive tank room sample filter unit. The spray additive tank room filter unit consists of a roughing filter, HEPA filter, charcoal absorber, a second HEPA filter, and fan. This unit combines makeup air from outdoors with recirculated air to both pressurize the room and remove radiation contamination in order to maintain the room habitable for plant personnel. The spray additive tank room sample filter unit exhausts air from the post-accident sampling system panel and discharges into the auxiliary building general exhaust system to prevent contamination from the panel being discharged to the room. The spray additive tank room sample filter unit consists of a canister HEPA filter, canister charcoal filter, and fan.

9.9.3.4 General Supply System

Normal make-up air from the outdoors for the engineered safety features ventilation system and the auxiliary building exhaust system is provided by the auxiliary building general supply system. This system consists of four 35,000 cfm capacity fans, 2 in each unit, with steam heating coils and air filters. There is no standby capacity in this supply air system.

Normally all fans operate at their design speed and direct outdoor air through the air filters and steam coils and into the building. The air is distributed throughout the building by the suction of the various exhaust ventilating systems.

The steam coils are activated during cold weather to temper the incoming air. Sufficient heat is added to the air flow to maintain the general ambient temperature of the building at or above the 60°F design minimum. Steam and/or electric heaters located in various areas of the building are used to ensure a satisfactory minimum temperature.

All ventilation system equipment is located within the building. During operation of either unit, all of its auxiliary building ventilation systems will be activated to "normal" operation. During shutdown of either unit, its auxiliary building ventilation systems may operate in part or in total to suit maintenance, inspection, testing, refueling, etc. conditions. .

9.9.4 Design Evaluation

The Auxiliary Building Ventilation and Heating Systems capacity is adequate for the maintenance of proper temperatures in the building under operating or shutdown conditions in all types of weather.

Sufficient redundancy is included in the Engineered Safety Features Ventilation System to insure proper operation of these systems with one active component out of service. In addition, one Engineered Safety Features exhaust fan is capable of providing sufficient airflow for the proper operation of the Component Cooling Water pumps and the Engineered Safety Features systems without reliance on the Component Cooling Water pump area supply fans or the Auxiliary Building general supply fans.

The Fuel Handling Area Ventilation System has sufficient redundancy to ensure proper operation of this system with one exhaust fan out of service. Charcoal, roughing and high efficiency particulate air filters on the Fuel Handling Area Exhaust System provide protection against release of radioactivity from this area to the atmosphere.

The General Ventilation System and the General Supply System each consist of two 50% capacity segments per unit with a crosstie between the Unit No. 1 and Unit No. 2 exhaust systems, thus minimizing the possibility of losing the total system of the plant unit.

Under normal operating conditions the total exhaust flow exceeds the total fan supply. Therefore all areas within the auxiliary building pressure boundary are at a negative pressure with respect to atmosphere. All exhaust flows from within the boundary are directed to the vent of the respective unit and monitored before release to atmosphere. All supply air is pre-filtered. The fuel handling area exhaust system is directed to the Unit 1 vent.

All systems are located within the building and generally grouped for ease of access, control and monitoring.

9.9.4.1 Test and Inspections

The systems are inspected, tested and balanced upon installation. Particulate and charcoal filters were individually tested by the manufacturer after fabrication and again after installation. The engineered safeguard ventilation system and the fuel handling area ventilation system are tested on a regularly scheduled basis over the life of the plant. Replacement filters will be tested in the same manner. Filter banks can be tested for leakage and dioctylphthalate smoke test efficiency while in place, and defective cells identified for removal and replacement.

9.10 CONTROL ROOM VENTILATION SYSTEM

9.10.1 General Description

The control rooms for Unit No. 1 and Unit No. 2 are both physically located on El 633' 0" of the auxiliary building with normal access from the turbine building. Control room air conditioning equipment is in an equipment room directly above the control room. Both control room envelopes are enclosed in a missile and tornado proof structure. The ventilation equipment room, the plant process computer room, and the control room are considered the Control Room Pressure Boundary (CRPB)/envelope. The control room ventilation system is shown in Figure 9.10-1.

9.10.2 Design Bases

The control room air conditioning system is designed to maintain room temperature within limits required for operation, maintenance and testing of plant controls and uninterrupted safe occupancy during post-accident shutdown.

The control room air conditioning system is designed to maintain a temperature of 85°F maximum dry bulb and 25-80 percent relative humidity under normal operating conditions. The design is based on outside temperatures ranging from -7°F winter dry bulb to 91°F summer dry bulb and 75°F summer wet bulb. The system operates during normal or emergency conditions as required.

Conditioned air is supplied to the Control Room envelope by either of two full-capacity air-handling units (one standby). Each unit includes a roughing filter, medium efficiency filter, chilled-water coil, and a fan. Downstream of each air handler in the duct system is an electric blast coil heater and a humidifier. Each unit is provided with chilled water from an associated liquid-chiller. Each air-handler/liquid-chiller combination is independently capable of fulfilling design objectives. Condenser water for each liquid chiller is taken from a different header of the Essential service water system. All Chiller packages are non-safety related sets of components qualified to Seismic Class I requirements and their performance has been evaluated for an ESW pump discharge temperature up to 90 °F. For emergency cooling essential service water can be manually diverted directly through the seismic Class I air handling coil, thus bypassing the liquid chillers.

Continuous pressurization of the Control Room envelope is normally provided by the air conditioning system to prevent the entry of dust and dirt. Emergency filtration and pressurization is provided by a separate air-handler with roughing filters, high efficiency particulate air filters and charcoal adsorbers. This unit can also be used in the recirculation mode as a cleanup system. Performance characteristics of the high efficiency particulate air filter cells provide for removal of as little as 99 percent of particulates. Performance characteristics of the charcoal adsorbers provide for removal of as little as 94.05 percent of methyl iodide, which includes a minimum charcoal filter efficiency of 95 percent and a maximum bypass leakage of one percent. All air conditioning equipment, pressurization fans and auxiliary equipment can be powered from emergency buses. The control room air conditioning system is designed to maintain room temperature within limits required for operation, maintenance and testing of plant controls and uninterrupted safe occupancy during post-accident shutdown.

9.10.3 System Operation

Two fresh-air intakes are provided for each Control Room envelope. Both air conditioning units share one intake. A separate intake is provided for the pressurizer/cleanup filter unit. The air handling units' fresh-air intake is fitted with redundant bubble tight motor-operated isolation dampers for Control Room envelope isolation. The pressurization/cleanup air intake is fitted with two motor-operated isolation dampers installed in parallel, each with 100% design flow capacity. Normally, a fixed proportion of room air and outside air is supplied to the Control Room envelope through one of the air-handling units. Temperature is controlled by thermostats located in the control room. Each liquid chiller has an independent control system. Outdoor air supplied to the Control Room envelope through the air-handling unit maintains a positive pressure with respect to the surrounding environs to prevent entry of dust, etc.

A toilet facility is located in the Unit No. 2 control room.

The Control Room Pressurization/Cleanup Filter Unit does not normally operate. In the event of a fire signal from the cable enclosure below the Control Room, the air conditioner fresh-air intake isolation dampers are closed, and one of the two isolation dampers in the pressurization system intake is opened. The Control Room Pressurization/Cleanup Filter Unit Fan starts. These operations are all performed automatically.

The Air Conditioning System then functions as a 100 percent recirculation system. The Pressurization/Cleanup Filter Unit fan supplies 100% pressurization air separately through the high efficiency particulate air and the charcoal filters before discharging into the Control Room envelope. The controls for isolating the normal fresh-air intake and starting the Emergency

Pressurization/Cleanup Filter Unit are located in both the Control Room and the air conditioning equipment room and can be manually actuated from either room.

A high radiation signal from the Unit 1 or Unit 2 Control Room radiation monitor or a Safety Injection signal, from either unit, automatically initiates closure of the isolation dampers in the Air Conditioning System. The Air Conditioning System then functions in the 100 percent recirculation mode. Upon receipt of these same signals, one of the two isolation dampers in the pressurization/cleanup system intake goes to a minimum position to allow sufficient outdoor air into the system to pressurize the Control Room envelope. The Control Room Pressurization/Cleanup Filter Unit fan automatically starts in the partial recirculation mode to remove radioactive particulates and iodines from within the Control Room envelope and from the outdoor ventilation air used for pressurization.

A manually actuated override control can be used to supply additional variable amounts of outside air (over and above the minimum makeup air required for pressurization in the cleanup mode) through the Emergency Pressurization/Cleanup Filter Unit to purge the Control Room atmosphere (outdoor conditions permitting).

9.10.4 Design Evaluation

The control room and the ventilation equipment room are both enclosed in a missile-and tornado-proof concrete structure. The ventilation equipment room is directly accessible from the control room. All other areas in the vicinity of the Control Room envelope such as cable spaces, auxiliary building, turbine building, etc. are ventilated by systems which are completely independent of the Control Room envelope ventilation system, thus fire or smoke generated in such other areas would not impair the integrity or accessibility of the Control Room envelope. Two independent, full capacity air conditioning systems serve each Control Room envelope. Two full capacity fans are provided for the Control Room Pressurization/Cleanup Filter Unit of each Control Room envelope. Redundant motor-operated isolation dampers are installed in series in the fresh-air intake for the control room air conditioning system. Parallel motor-operated isolation dampers are installed in the intake for the Pressurization/Cleanup Filter Unit System. This redundancy ensures proper room conditions with one active component out of service or inoperable.

9.10.5 Incident Control

A safety injection signal automatically closes the normal control room air intake dampers, thus preventing possibly contaminated air from entering the room. The control room pressurization/cleanup filter unit is automatically operated to remove any particulates or iodine which may leak into the Control Room envelope. In the event the control room liquid chillers are not available, plant operation may continue provided Essential Service Water (ESW) is diverted directly through the air handling units and ESW supply temperature is ≤ 65°F.

9.10.6 Tests and Inspection

The systems were inspected, tested and balanced upon installation. Periodic testing is performed to insure system operability.

High efficiency particulate air filters and charcoal filters are tested after fabrication by the manufacturer, again after installation and periodically over the life of the plant.

9.10.7 Malfunction Analysis

A failure analysis of the Control Room Ventilation System is presented in Table 9.10-1.