9.4.11 Essential Service Water Pump Building Ventilation System

The essential service water pump building ventilation system (ESWPBVS) provides conditioned air to the essential service water system (ESWS) pump areas and associated electrical equipment areas. The ESWPBVS provides an environment suitable for the operation of the ESWS pumps (refer to Section 9.2.1) and associated electrical equipment by maintaining acceptable temperature conditions in each of the four ESWS Pump Buildings. Each building has its own independent ventilation system and is not connected to the other buildings.

9.4.11.1 Design Bases

All components of the ESWPBVS are safety related and designed to Seismic Category I requirements. The ESWPBVS performs the following safety-related system functions and complies with the general design criteria (GDC) indicated below:

- The ESWPBVS maintains acceptable temperature limits to support operation of the ESWS pumps that are required to operate during design basis accident conditions. The ESWPBVS maintains a minimum temperature of 41°F and a maximum temperature of 104°F in the ESWS Pump Buildings for personnel accessibility and to support operation of the ESWS pumps. This temperature range maintains a mild environment in these buildings, as defined in Section 3.11.

- The ESWPBVS components are located inside the ESWS Pump Buildings, which are designed to withstand the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, and external missiles (GDC 2).

- The ESWPBVS components are appropriately protected against dynamic effects and designed to accommodate the effects of, and to be compatible with, the environmental conditions associated with normal operation, maintenance, testing and postulated accidents. The components of the ESWPBVS remain functional and perform their intended safety function after anticipated operational occurrences and design basis accidents, such as a fire, internal missiles, or pipe break (GDC 4).

- The safety-related components and systems of the ESWPBVS are not shared among nuclear power units (GDC 5).

- The essential onsite electrical power systems meet the guidance of NUREG-CR/0660 (Reference 1) (subsection A–item 2, and subsection C-item 1) for protection of essential electrical components (such as contactors, relays, circuit breakers) from failure due to the accumulation of dust and particulate materials (GDC 17).

- Power and control functions are designed in accordance with RG 1.32.

Air conditioning and heating loads for the ESWS pump rooms are calculated using methodology identified in ASHRAE Handbook (Reference 8).

- Summer air conditioning loads will be calculated with a maximum outside air design temperature 0 percent exceedance value, using U.S. EPR Site Design Envelope Temperature (See Table 2.1-1). The analysis will be completed for both a normal and accident plant alignment configuration.

- The cooling supply units are designed to provide cooling as required to prevent the ESWS pump room temperatures from exceeding their maximum design temperature.

- Winter heating loads will be calculated with the plant operating in an outage alignment configuration. Winter heat loads will be calculated with a minimum outside air design temperature 0 percent exceedance value, using U.S. EPR Site Design Envelope Temperature (See Table 2.1-1).

9.4.11.2 System Description

9.4.11.2.1 General Description

A drawing of the ESWPBVS applicable to each of the four ESWS Pump Buildings is shown in Figure 9.4.11-1—Essential Service Water Pump Building Ventilation System.

The ESWPBVS supplies the recirculation air for cooling or heating of the ESWS pump area and electrical equipment area located inside each of the four ESWS Pump Buildings. Each building has its own independent ventilation system.

This ventilation system is not expected to contain or interface with any radioactive materials, and so is not considered an Engineered-Safety-Feature Atmospheric Clean-Up System.

Room air is drawn through an air inlet grill and processed through an air conditioning train. The conditioned air is supplied to the ESWS pump area and electrical equipment area. The room air is then returned to the air conditioning train. The air conditioning train for each building is comprised of the following components:

- Recirculation supply air ductwork.

- Cooling coils, which cool the recirculation air to the required supply air temperature, have a total cooling capacity of 619,400 Btu/hr. The cooling coils are supplied with water from the ESWS pump and the water is discharged into the respective cooling tower basin. Manual isolation valves are provided to isolate the cooling coils for maintenance.

- Moisture separator, which drains the condensate to the cooling tower basin.

- Heaters, which heat the recirculation air during winter conditions to maintain the minimum required temperature.

- Supply air recirculation fans, are designed to provide an air flow rate of 30,000 scfm.

- Supply air louver dampers, which control the air flow to the ESWS pumps area and electrical equipment area.

9.4.11.2.2 Component Description

The major components of the ESWPBVS are listed in the following paragraphs, along with the applicable codes and standards. Table 3.2.2-1 provides the seismic design and other design classifications for components in the ESWPBVS.

Ductwork and Accessories

The supply air duct is constructed of galvanized sheet steel and is structurally designed for the fan shutoff pressure. The ductwork meets the design, construction and testing requirements of ASME AG-1 (Reference 2).

Cooling Coils

The cooling coils are designed in accordance with Reference 2.

Cooling Coil Isolation Valves

The cooling coil isolation valves are designed to meet ASME Boiler and Pressure Vessel Code, Section III, Class 3 (Reference 7).

Moisture Separators

Each moisture separator is installed to collect the condensate which is directed to the cooling tower basin.

Electric Heaters

The electric heaters meet the requirements of Reference 2.

Air Supply Fan

The fan is centrifugal or axial type with an electrical motor driver. Fan performance is rated in accordance with ANSI/AMCA-210 (Reference 4), ANSI/AMCA-211 (Reference 5), and ANSI/AMCA-300 (Reference 6).

Isolation Dampers

Manual dampers are adjusted during initial plant testing to establish an accurate flow balance. The performance and testing requirements of the dampers are per Reference 2.

9.4.11.2.3 System Operation

Normal Plant Operation

During normal plant operation, two ESWS pumps are in operation. The room air is recirculated through the air conditioning train, which supplies the required air flow at the required temperature. During winter, the recirculated air is heated by the electric heaters to maintain the required temperatures in the building. The heaters automatically start when the room temperature drops to 41°F, and shut off when it rises above 60°F.

The ESWPBVS also functions when the ESWS pumps are not in operation to maintain acceptable room temperatures for start of the ESWS pumps and personnel comfort. The room temperature is monitored by the temperature sensors for each building.

Abnormal Operating Conditions

If one or more components of the ESWPBVS fail, the ESWPBVS is not able to maintain the required ambient conditions in the affected building. Because there are four independent ESWS pump buildings, the failure in one building does not affect the other three buildings.

Loss of Off-Site Power

In the event of loss of offsite power (LOOP), the ESWPBVS continues to operate. The power is supplied from the Class 1E emergency power supply system (EPSS).

Station Blackout

In the event of station blackout (SBO), the ESWPBVS is not operable.

Plant Accident Conditions

The ESWPBVS is required to operate during design basis accident conditions. Even if the ESWS pumps are not required to operate, the ESWPBVS maintains conditions in the ESWS pump buildings in case the ESWS pumps are required to operate.

9.4.11.3 Safety Evaluation

The ESWPBVS has sufficient cooling capacity to maintain the pump room temperature below 120°F when the ESWS pump motors are operating at rated load and the outside air is at the maximum site design ambient temperature of 115°F. The heater is controlled by a local temperature control system having a predetermined temperature setpoint.

The ESWPBVS is located in the ESWS Pump Building, which is designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other

similar natural phenomena. Section 3.3, Section 3.4, Section 3.5, Section 3.7, and Section 3.8 provide the bases for the adequacy of the structural design of these buildings.

The components of the ESWPBVS remain functional and perform their intended safety function after anticipated operational occurrences and design basis accidents, such as a fire, internal missiles, or pipe break (GDC 4). Section 3.5.1.1 provides the bases for this determination for internally generated missiles outside containment. For missiles generated by tornadoes and extreme winds, see Section 3.5.1.4 and Section 3.5.2. Piping failures due to high energy line breaks are addressed in Section 3.6.1.

Since redundancy of the ESWPBVS is provided, no single failure compromises the safety functions of the system. Vital power is supplied from either onsite or offsite power systems, as described in Chapter 8.

The power supplies and control functions necessary for safe function of the ESWPBVS are from a Class 1E system, as described in Chapter 7 and Chapter 8.

9.4.11.4 Inspection and Testing Requirements

The ESWPBVS major components, such as dampers, motors, fans, filters, coils, heaters, and ducts are located to provide access for initial and periodic testing to verify their integrity.

Test and analysis will be completed during normal operation with the system operating in an accident alignment. Analysis will use as-built information from equipment to extrapolate the performance of the air-conditioning system. Analysis will show that the equipment performance is adequate to maintain design conditions during plant operating conditions.

Initial in-place acceptance testing of the ESWPBVS is performed as described in Section 14.2 (test abstracts #088 and #203), Initial Plant Test Program, to verify the system is built in accordance with applicable programs and specifications.

The ESWPBVS is designed with adequate instrumentation for differential pressure, temperature, and flow indicating devices to enable testing and verification of equipment function, heat transfer capability and air flow monitoring.

During normal plant operation, periodic testing of ESWPBVS is performed to demonstrate system and component operability and integrity.

Isolation dampers are periodically inspected and damper seats replaced as required.

Fans are tested by the manufacturer in accordance with Air Movement and Control Association (AMCA) standards (References 4, 5, and 6). Air filters are tested in accordance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards (Reference 9). Cooling coils are hydrostatically tested in accordance with ASME AG-1 (Reference 2) and their performance is rated in accordance with the Air Conditioning and Refrigeration Institute (ARI) standards (Reference 10).

Housings and ductwork are leak-tested in accordance with the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) technical manual "HVAC Air Duct Leakage Test Manual" (Reference 11), and ASME AG-1 (Reference 2).

Heaters are tested in accordance with ASME AG-1, Section CA (Reference 2).

Periodic testing and inspections identify systems and components requiring corrective maintenance, and plant maintenance programs correct deficiencies.

9.4.11.5 Instrumentation Requirements

Indication of the operational status of the equipment, instrument indications and alarms are provided in the main control room (MCR). Fans and heaters are operable from the MCR. Local instruments are provided to measure flow, temperature and pressure. The fire detection and sensors information is delivered to the fire detection system.

9.4.11.6 References

1. NUREG-CR/0660, Boner, G.L. and Hanners, H.W., "Enhancement of Onsite Emergency Diesel Generator Reliability," University of Dayton Research Institute UDR-TR-79-07 for U.S. Nuclear Regulatory Commission, January 1979.

2. ASME AG-1, "Code on Nuclear Air and Gas Treatment," The American Society of Mechanical Engineers, 1997 (including the AG-1a-2000, "Housings," Addenda).

3. ASME N510-1989 (R1995), "Testing of Nuclear Air-Treatment Systems," The American Society of Mechanical Engineers, 1989.

4. ANSI/AMCA-210-99, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating," American National Standards Institute/Air Movement and Control Association International, December 1999.

5. ANSI/AMCA-211-1987, "Certified Ratings Program–Air Performance," American National Standards Institute/Air Movement and Control Association International, 1987.

6. ANSI/AMCA-300-1985, "Reverberant Room Method of Testing Fans for Rating Purposes," American National Standards Institute/Air Movement and Control Association International, 1985.

7. ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear Facility Components,” Class 3 Components, The American Society of Mechanical Engineers, 2004.

8. “ASHRAE Handbook Fundamentals,” American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc., 2005.

9. ANSI/ASHRAE Standard 52.2-1999, " Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size," ANSI/ American Society of Heating, Refrigerating and Air Conditioning Engineers, 1999.

10. ANSI/ ARI Standard 410-2001, "Forced-Circulation Air-Cooling and Air-Heating Coils," Air Conditioning and Refrigeration Institute, 2001.

11. "HVAC Air Duct Leakage Test Manual," Sheet Metal and Air Conditioning Contractors' National Association, 1985.

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