9.4.9 Emergency Power Generating Building Ventilation System

The emergency power generating building ventilation system (EPGBVS) maintains acceptable ambient conditions and air renewals of the diesel hall, electrical room, and main tank room of each of the four divisions of the Emergency Power Generating Buildings (EPGB). Each division has its own independent heating, ventilation and air conditioning (HVAC) system which is not connected to other divisions. Two divisions are located in each of the two EPGBs.

9.4.9.1 Design Bases

The EPGBVS consists of safety-related and non-safety-related air supply and exhaust systems. The safety-related portion is designed to Seismic Category I requirements, and the non-safety-related portion is designed to Seismic Category II requirements. The EPGBVS performs the following safety-related system function and complies with the general design criteria (GDC) indicated below:

- The EPGBVS maintains acceptable temperatures and air renewals in each of the four divisions to support the operation of the emergency diesel generators (EDG) and electrical control panels. The EDGs are required to provide onsite emergency power for the safety-related equipment to achieve and maintain the plant in a safe shutdown condition following a design basis accident, including loss of offsite power (LOOP).

- In accordance with GDC 2, the EPGBVS components are located inside the EPGBs, which are designed to withstand the effects of natural phenomena, such as earthquakes, tornados, hurricanes, floods and external missiles.

- In accordance with GDC 4, the EPGBVS components remain functional and continue to perform their intended safety function after anticipated operational occurrences and design basis accidents, such as fire, internal missiles, or pipe breaks.

- In accordance with GDC 5, the safety-related components and systems of the EPGBVS are not shared with other nuclear power units.

- In accordance with GDC 17, the U.S. EPR contains an onsite and offsite electric power system that supports the functioning of structures, systems, and components important to safety in the event of postulated accidents and anticipated operational occurrences. The EPGBVS maintains a minimum clearance of 20 feet from the bottom of fresh air intakes to grade elevation, and electrical cabinets are provided with suitable seals or gaskets, These features maintain proper functioning of the essential electric power system by meeting the guidelines of NUREG-CR/0660 (Reference 1), as related to the accumulation of dust and particulate material.

  The essential onsite electrical power systems meet the guidance of NUREG-CR/0660 for protection of essential electrical components (such as contactors, relays, circuit breakers) from failure due to the accumulation of dust and particulate

materials. This is accomplished by the use of filters and supply air units in the EPGBVS.

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

- Summer cooling 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 with EDG in operation.
- The cooling supply units are designed to provide outside air for cooling as required to prevent the EDG room temperatures from exceeding their maximum design temperature.
- Winter heating loads will be calculated with the plant operating in an outage alignment configuration, without diesel operation. 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).

Though the EDGs are in standby mode during normal plant operation, the EPGBVS is available in any plant operating condition. With outside air ambient design temperature conditions of -40°F to 115°F, the EPGBVS is designed to meet the following safety-related functional criteria:

- Maintains the diesel hall temperature between 59°F and 140°F.
- Maintains the electrical room temperature between 40°F and 113°F with 10 to 60 percent relative humidity.
- Maintains the main tank room temperature between 59°F and 120°F.

The EPGBVS performs the following non-safety system functions:

- Provide outside air and cooling to the diesel hall when the EDGs are not in operation, or safety-related supply and exhaust fans are not required to operate.
- Provide outside air and cooling to the electrical room.

9.4.9.2 System Description

9.4.9.2.1 General Description

The EPGBVS ventilates the diesel generators using outside air as the cooling medium. Air is supplied into the building to slightly pressurize the building, and is then vented from the building through exhaust air louver openings.

The EPGBVS includes ventilation of diesel divisions 1 through 4. Divisions 1 and 2 are located inside the EPGB located on one side of the Reactor Building (RB), and

divisions 3 and 4 are located inside the EPGB located on the opposite side of the RB. Each division has a separate and independent HVAC system. The HVAC systems for each of the four divisions are identical.

The air intake and exhaust stack of the EPGBVS are located such that exhaust gases being drawn into the air inlet stream are limited to an insignificant level. The exhaust stack is located approximately 70 feet from the air intake, and the exhaust air flow is directed away from the air intake flow.

One of the divisions of the EPGBVS is illustrated in Figure 9.4.9-1—Emergency Power Generating Building Ventilation System. The other three divisions are identical.

The EPGBVS consists of following subsystems for each division:

- Ventilation of diesel hall.
- Ventilation of electric room.
- Ventilation of main tank room.

Ventilation of Diesel Hall

The outside air is drawn into the HVAC supply room through an air intake screen or grill which prevents large objects from entering the air intake. The fresh air intake is located approximately fifty feet above grade elevation and is protected against hurricane and tornado missiles. The screen or grill is heated during the winter to prevent ice buildup.

The air from the HVAC supply room is supplied through two separate air trains which include back draft damper, prefilter, and supply fan. Each diesel hall supply and exhaust fans maintain the diesel hall temperature between 59°F and 140°F. The supply air is delivered through ductwork to the diesel hall.

An additional non-safety-related air supply and exhaust ventilation system to the diesel hall is also installed that operates when the large safety-related supply and exhaust system is not required to operate during maintenance or when the moderate outside temperature does not allow the large supply and exhaust fans to operate. The non-safety-related air supply is drawn from the HVAC supply room, the system includes an air intake screen or grill, backdraft damper, prefilter, supply fan, motor operated damper, and manual damper. The non-safety-related air exhausts to the HVAC air exhaust room, the system includes a motor operated damper, exhaust fan and backdraft damper.

The non-safety-related ventilation system prevents frequent starting and stopping of the large safety-related supply and exhaust fans. A safety-related temperature sensor in the diesel hall controls operation of one or both safety-related supply/exhaust fans

as required to maintain design temperature in the diesel hall. Initially, the non-safety fans operate, and as the diesel hall temperature increases both safety-related supply/ exhaust fans start operating. Operation of safety-related fans shuts down the non-safety fans and closes the motor operated dampers. A separate safety-related temperature sensor in the diesel hall provides low/high room temperature alarm in the MCR. This sensor also closes the safety-related motor operated dampers located on the non-safety-related air supply/exhaust system when the diesel hall temperature reaches at or below 59°F.

During winter conditions, when the EDGs are not in operation, the air in the diesel hall is recirculated through four electrical fan heaters. These fans are controlled by local thermostats to maintain the required minimum temperature.

The exhaust air from the diesel hall is directed to the HVAC exhaust room through two separate ducts which include an exhaust fan and a back draft damper. The exhaust plenum is split into two sections: one is for the diesel engine exhaust, and the other is for HVAC exhaust. This separation of exhaust prevents diesel exhaust back pressure from affecting the HVAC exhaust ventilation fans. This boundary prevents inadvertent entry of diesel engine exhaust into the diesel room if one of the HVAC exhaust damper fails to close. This partition also protects the HVAC equipment and improves working environment inside the area.

Ventilation of Electric Room

A non-safety-related inlet air supply for the electrical room is drawn from outside air through a motor operated damper, manual damper, prefilter, refrigerant evaporator cooler, and fan. The operation of this unit is automatically controlled by a room thermostat that maintains the electrical room temperature between 40°F and 113°F. A safety-related temperature sensor located outside under a hurricane and tornado protective hood, sends a signal to open or close the safety-related motor operated damper that is located on the non-safety-related inlet air supply. This damper automatically closes when outside air temperature is below 50°F or above 100°F. This prevents entry of hot or cold outside air. The non-safety-related cooling system operates only when the EDGs are not operating. A backdraft damper is installed at the boundary of electrical room and diesel hall to allow the electrical room air to exhaust to the diesel hall.

A safety-related cooling system for the electrical room operates when the EDGs are also operating. This system recirculates the electrical room air through an air conditioning unit that consists of manual damper, prefilter, HEPA filter, cooling coil, moisture separator, and supply fan. The fan air flow maintains electrical room temperature within the design temperature limits of 40°F and 113°F. The water for the cooling coil is supplied from the ESW system. The recirculated air from the electrical room is controlled to maintain ambient conditions inside the electrical room.

Ventilation of Main Tank Room

The air supply to the main tank room is drawn from the diesel hall or HVAC supply air room through an electric louver damper, a back draft damper, and a fire damper. The exhaust air from the main tank room is directed through louver damper, exhaust fan, and a back draft damper. The exhaust air is then directed to the building exhaust through an outlet screen or grill. The exhaust fan is designed to maintain the required ventilation rate of the main tank room. The main tank room exhaust design air flow is 3,200 scfm. During winter, local heaters maintain the required minimum temperature inside the main tank room. These heaters are controlled by local thermostats.

9.4.9.2.2 Component Description

The major components of the EPGBVS 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 EPGBVS.

Ductwork and Accessories

The supply and exhaust air ducts are constructed of galvanized or stainless steel plates or sheets, and structurally designed for fan shutoff pressures. The ductwork meets the design, testing and construction requirements of ASME AG-1 (Reference 1).

Electric Heaters

The electric heaters are installed in the main tank room to maintain room ambient conditions and controlled by local room temperature sensors. Electrical heating coils are fin tubular type and meet the requirements of ASME AG-1 (Reference 1).

Fan Heaters

Fan heaters are used in the diesel hall to maintain acceptable temperature in the area. The fan heaters include a fan and electric heater. These fan heaters are controlled by a thermostat.

Prefilters

Prefilters are located upstream of HEPA filters and on all supply air inlets. The prefilters meet the requirements of ANSI/ASHRAE Standard 52.2 (Reference 2).

HEPA Filters

HEPA filters are constructed, qualified and tested in accordance with ASME AG-1 (Reference 1). The periodic inplace testing of HEPA filters to determine the leak-tightness is performed in accordance with ANSI/ASME N510 (Reference 3).

Fans

The supply and exhaust fans are centrifugal or axial type with electrical motor drivers. Fan performance is rated in accordance with ANSI/AMCA 210 (Reference 4), AMCA 211 (Reference 5), and ANSI/AMCA 300 (Reference 6).

Isolation Dampers

Manual dampers are adjusted during initial plant testing to establish accurate flow balance between the rooms. The motor-operated dampers will fail as-is in the case of power loss. Backdraft dampers prevent air flow to non-operating air supply and exhaust trains. The performance and testing requirements of the dampers are in accordance with ASME AG-1 (Reference 1).

Fire Dampers

Fire dampers are installed where ductwork penetrates a fire barrier. Fire damper design meets the requirements of NFPA 80 (Reference 7) and NFPA 90A (Reference 11) and the damper fire rating is commensurate with the fire rating of the barrier penetrated. Fire dampers are equipped with fusible links for automatic closure when the temperature reaches a predetermined setpoint.

Cooling Coils

Cooling coils are installed in the supply and recirculation train for cooling of the electrical room. The cooling coils are of finned tube coil type and designed in accordance with ASME AG-1 (Reference 1). The coil in the non-safety air cooling system is cooled using a refrigerant evaporator cooler. The safety recirculation cooling coil is cooled by the ESW system.

Moisture Separator

The moisture separator is installed in the air conditioning train to collect condensate, which is directed to the drain system.

9.4.9.2.3 System Operation

Normal Plant Operation

The EPGBVS maintains acceptable ambient conditions in the diesel hall, electric room, and main tank room of each of the four EPGB divisions. During normal plant operation, the EDGs do not operate. However, outside air is supplied to the diesel hall to maintain an acceptable ambient temperature for the startup of the EDGs and personnel comfort. In winter conditions, four fan heaters are available to maintain the required minimum temperature in the diesel hall. When the EDGs are in operation, the exhaust air removes the heat generated in the diesel hall. The operation of air

supply fans and the opening of dampers depend on the diesel hall temperature detected by the sensors. The diesel hall temperature is kept in the appropriate band by controlling the position of dampers and operating the air supply fans.

Air renewals for the diesel hall and main tank room are maintained as needed to obtain the required ambient temperatures. The non-safety-related split system air conditioner supplies the electrical room with outside air that is mixed with the recycled air from the electrical room. The mixed air is then processed through the air conditioning train and supplied to the electrical room. The safety-related ESW cooling unit will operate only when the EDGs are operating or during the tests of EDGs.

The main tank room is ventilated by air supplied from the HVAC supply air room or diesel hall. The main tank room air is discharged through the exhaust duct to an exhaust fan and then out of the building. The main tank room is heated by a local electric heater, which is activated by a thermostat to maintain a minimum required room temperature.

Fire dampers are located on the ventilation system to avoid fire propagation in the building. The rooms are completely isolated in case of a fire in the room.

Abnormal System Operating Conditions

Failure of Diesel Hall Air Supply

If one or more components of the diesel hall supply air fail, the EPGBVS is not able to maintain the required ambient conditions. At lower outside temperature, the system uses only one supply fan to provide sufficient ventilation for the proper operation of the EDGs. Since there are four redundant EPGB divisions, the failure of the diesel hall air supply in one division does not affect the other three divisions.

Failure of Diesel Hall Fan Heater

The diesel hall has four fan heaters. In the case of failure of one heater fan, the other three fans are able to maintain the required temperature in the diesel hall.

Failure of Electric Room Safety-Related Air Cooling Unit

In the case of failure of a component on the safety-related air conditioning train for the electric room, the required ambient conditions are not maintained in the electric room when EDG is operating. However, other unaffected divisions are available to provide necessary power during this event.

Failure of Exhaust Components

In the case of failure of any of the EPGBVS exhaust components, proper ambient conditions are not maintained. However, other unaffected divisions are available to provide necessary power during this event.

Loss of Offsite Power

In the event of LOOP, the emergency power to the safety-related EPGBVS components is supplied by the corresponding supported diesel generator. Therefore the safety-related ventilation system is not affected by the LOOP. The safety-related EPGBVS actuators are supplied with emergency power. During operation of the diesel generators with a maximum outside air ambient design temperature of 115°F, the room temperature may rise to a maximum of 140°F.

Station Blackout

In the event of a station blackout (SBO), diesel generator power is not available. The EPGBVS is not functional during the SBO event. Since the diesel generators are not operating, the temperature within the building will increase only slightly because no significant heat loads are present. The temperature within the EPGBs will remain at an acceptable level to support the operability of the diesels.

9.4.9.3 Safety Evaluation

The EPGBVS is designed to maintain ambient conditions inside the EPGB to allow safe operation of the diesel generators. The maximum temperature of 140°F in the diesel hall is the design temperature based on an outside ambient temperature of 115°F and heat loads due to operating EDGs and other electrical loads. The equipment inside the diesel hall is designed to a temperature of 140°F. The ambient conditions inside the EPGB are normally maintained acceptable for personnel access.

The EPGBVS is located inside of the EPGB, which is designed to withstand effects of earthquake, tornadoes, hurricanes, floods, external missiles and other natural phenomena. Chapter 3 provides the bases for adequacy of the structural design of the EPGBs.

The EPGBVS remains functional after a safe shutdown earthquake (SSE) event. Chapter 3 provides the design loading conditions, and Section 7.4 addresses the systems required for safe shutdown.

Redundancy is provided for the EPGBVS components and no single failure compromises the safety function of the system. Vital power is supplied from onsite or offsite power systems.

9.4.9.4 Inspection and Testing Requirements

The EPGBVS 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 EPGBVS is performed as described in Section 14.2 (test abstracts #084 and #203), Initial Plant Test Program, to verify the system is built in accordance with applicable programs and specifications.

The EPGBVS 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 EPGBVS 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 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 2). Cooling coils are hydrostatically tested in accordance with ASME AG-1 (Reference 1) and their performance is rated in accordance with the Air Conditioning and Refrigeration Institute (ARI) standards (Reference 9).

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 10), and ASME AG-1 (Reference 1).

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

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

9.4.9.5 Instrumentation Requirements

Indication of the operational status of the equipment, position of dampers, instrument indications and alarms are provided in the MCR. Fans, motor-operated dampers,

heaters and cooling units are operable from the MCR. Local instruments are provided to measure differential pressure across filters, flow, temperature and pressure. The fire detection and sensors information is delivered to the fire detection system.

9.4.9.6 References

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

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

3. ANSI/ASME N510-1989, "Testing of Nuclear Air-Treatment Systems," American National Standards Institute/The American Society of Mechanical Engineers, 1989.

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

5. AMCA Publication 211-87, "Certified Ratings Program – Air Performance," Air Movement and Control Association International, 1987.

6. ANSI/AMCA Standard 300-85, "Reverberant Room Method of Testing Fans for Rating Purposes," American National Standards Institute/Air Movement and Control Association International, 1985.

7. NFPA 80, "Standard for Fire Doors and Other Opening Protectives," National Fire Protection Association Standards, 2007.

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

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

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

11. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilation Systems," National Fire Protection Association Standards, 2002.

Next File