9.4.8 Radioactive Waste Processing Building Ventilation System

The radioactive waste processing building ventilation system (RWBVS) provides fresh conditioned air to the Radioactive Waste Processing Building (RWB) to maintain acceptable ambient conditions within the building. There are two exhaust air systems - system exhaust air, which draws air from locations where radioactivity is likely, and room exhaust air (Cells 1 and 2), which draws air from locations not normally expected to contain radioactivity. The RWBVS provides filtration of exhaust from the RWB to limit the release of airborne contaminants exhausted from the vent stack. Additionally, the RWBVS maintains sub-atmospheric pressure in the RWB, to prevent the release of airborne contaminants into the outside atmosphere. The RWBVS functions during normal plant operation.

9.4.8.1 Design Bases

The RWBVS is non-safety-related and is located in a building that is not Seismic Category I. The U.S. EPR meets:

- GDC 2, as it relates to meeting the guidance of RG 1.29 for radioactive waste management systems to be designed in accordance with RG 1.143.
- GDC 5, as it relates to the RWBVS because there are no safety-related components that are shared with any other nuclear power units.
- GDC 60, as it relates to the ability of the system to limit the release of gaseous radioactive effluents to the environment. The RWBVS exhaust filtration units are designed, tested, and maintained in accordance with RG 1.140. The air flow rate of a single cleanup filtration unit will not exceed 30,000 cfm.

The RWBVS performs no safety-related function and is Non-Seismic. Failure of the system does not affect the reactor coolant system (RCS) pressure boundary or the safe shutdown of the plant; nor is the system required to mitigate the consequences of a 10 CFR Part 100 release.

The RWBVS performs the following non-safety-related system functions:

- Maintains the RWB at sub-atmospheric pressure. Maintaining the building sub-atmospheric is accomplished by flow balancing of the intake and exhaust air flow with air dampers.
- Maintains adequate building temperatures for personnel in the working areas and removes waste heat from the equipment located in the building. The RWBVS maintains the following temperature and humidity values in the RWB permanent working areas based on normal outdoor temperatures specified in Table 2.1-1:
  - Temperature from 68° to 91°F.
  - Humidity from 10 to 70 percent.

- Removes radioactivity from the system exhaust air by the use of high efficiency particulate air (HEPA) filters and iodine adsorption charcoal filtration units.

9.4.8.2 System Description

9.4.8.2.1 General Description

The RWBVS supplies conditioned outside air and processes and removes the exhaust from the RWB. This once-through ventilation system has no air recirculation capability except for the evaporator, instrumentation and controls (I&C), and the vehicle access rooms. A simplified sketch of the RWBVS is shown in Figure 9.4.8-1 and Figure 9.4.8-2.

The outside air is provided through intake mesh grilles and louver dampers. The outside air intake openings are equipped with electrically heated and weather protected grilles to prevent ice formation and ingress of insects and debris.

Depending on outdoor conditions, the supply air to the RWB is filtered, cooled and filtered, and heated by the supply air system. If required, electric heaters installed in the supply air ductwork provide additional heating of the supply air.

The supply air system shown in Figure 9.4.8-1 consists of two air handling units; both units supply air to two supply fans. Each air handling unit consists of a preheater, prefilter, cooling coil, system heater, fan, and back draft damper. The back draft damper prevents short cycling supply air through the non-operating supply fan. Downstream of the air handling units in the common supply air duct is a motor-driven supply damper that maintains the sub-atmospheric pressure in the RWB by decreasing or increasing the supply air flow as required. The air handling units, supply fans, and supply damper are located in the RWB at elevation +36 ft.

The operational chilled water system (OCWS) supplies chilled water to the air cooling coil. The preheater and the system heater are supplied with hot water by the space heating system (SHS). The air cooling coil and system heater condition the supply air to maintain RWB temperatures. The preheater prevents freezing during cold weather conditions. In the event the preheater cannot prevent freezing, a signal is generated by a temperature sensor indicating that the air temperature leaving the preheating coils is low, the supply air fans shut down automatically and the air inlet dampers on the air intake close automatically to avoid freezing the equipment.

During normal operation, the RWBVS provides fresh air to the RWB stairwells.

Radiation Monitors R-23 (decontamination room) and R-24 shown in Figure 9.4.8-1 provide airborne and sampling points (refer to Section 11.5.3.1.8 and Table 11.5-1). The radiation monitors (R-23 and R-24) provide local and control indications, but do not initiate any automatic control functions.

The RWB has two exhaust air systems–system exhaust air and room exhaust air (see Figure 9.4.8-2).

System exhaust air draws air from RWB locations where radioactivity is likely. The exhaust air and gases from activity-bearing systems, vented air from tanks and releases from working areas and machinery are collected by the system exhaust air. The exhaust air is monitored by the sampling activity monitoring system (SAMS) prior to entering the system exhaust air filtration system. System exhaust air is continuously filtered by two filter systems consisting of prefilters, HEPA filters, iodine adsorption charcoal filters, and post filters. The treated air is then exhausted to the vent stack by two exhaust fans located in the RWB at elevation +36 ft. Air temperature and relative humidity are maintained within design requirements by water droplet separators and electrical heaters installed upstream of the filter trains. The system exhaust air has no automatic isolation functions. In the event of a high radiation alarm from the SAMS (refer to Section 11.5.3.1.8 and Table 11.5-1, Monitor R-21), operators can manually shutdown the RWBVS from the main control room (MCR).

Room exhaust air serves the rooms in RWB that are not normally expected to contain radioactivity. Room air is monitored by the SAMS prior to entering the filtration units. During normal operation, the clean room exhaust air bypasses the filtration units, and the exhaust air is directed to the vent stack. If radioactivity is detected by the SAMS (refer to Section 11.5.3.1.8 and Table 11.5-1, Monitors R-20 and R-22) in any of the rooms served by the room exhaust air system, the contaminated air is automatically rerouted through the iodine filtration unit prior to release to the vent stack. There are two parallel 50 percent filtration units. Each filtration train consists of two motor operated isolation dampers, heater, prefilter, HEPA filter, carbon adsorber, and post filter. The exhaust air is directed through two 50 percent exhaust fans to the vent stack.

Refer to Section 12.3.6.5.6 for ventilation system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.4.8.2.2 Component Description

The major components of the RWBVS are described in the following paragraphs. Table 3.2.2-1 provides the seismic design and other design classifications for components in the RWBVS.

Ductwork and Accessories

The supply and exhaust air ducts are structurally designed for fan shutoff pressures. The ductwork is designed, tested, and constructed in accordance with ANSI/ASME N509 (Reference 11) and ANSI/ASME N510 (Reference 3).

Supply Air Handling Units

Each of the two supply air handling units consists of a housing, a preheater, a heater, a cooler, a prefilter, and a filter. The outlets of the air handling units combine into a common duct that provides supply air to two parallel supply fans. The outlet of the two supply fans combine into a common duct.

System Exhaust Air Handling Units

Each of the two exhaust air handling units consists of an airtight housing, electric heater, prefilter, HEPA filter, carbon adsorber, post filter, and motor operated inlet and outlet dampers. The outlets of both air handling units join into a single line and then separate to supply the inlets of the two parallel exhaust fans, allowing each air handling unit to supply either exhaust fan.

Room Exhaust Air Iodine Filtration Unit

Each of the two parallel room exhaust iodine filtration units consist of an air-tight housing, electric heater, prefilter, HEPA filter, carbon adsorber, post filter, and motor operated inlet and outlet isolation dampers. The exhaust air is routed through two parallel exhaust fans to the vent stack.

Supply, System Exhaust, Room Exhaust, and Iodine Filter Unit Booster Fans

The supply, exhaust, and iodine filter unit booster fans are centrifugal type fans and are directly driven by the shaft of an electric motor. The fans are designed and rated in accordance with ANSI/AMCA 210 (Reference 4), AMCA 211 (Reference 5), and ANSI/AMCA 300 (Reference 6).

Isolation Dampers

The isolation dampers are located upstream and downstream of each filtration train. The motor-operated dampers will fail as-is in case of loss of power. Backdraft dampers prevent air flow to non-operating air supply and exhaust trains. The performance and testing requirements of the dampers are per ASME AG-1 (Reference 1).

Electric Heaters

Electric heaters meet the requirements of ASME AG-1 (Reference 1).

Heating and Cooling Coils

Preheating, heating, and cooling coils are of the continuous tube type, which are made of finned tubes with return bends providing continuous and uninterrupted flow of water within each tube.

Prefilters

The prefilters are located upstream of HEPA filters and collect large particles to increase the useful life of the HEPA filters. 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 in-place testing of HEPA filters to determine the leak-tightness is performed per ANSI/ASME N510 (Reference 3).

Adsorbers

Carbon adsorbers are used to remove radioactive iodine from the exhaust air. The efficiency for removal of methyl iodine is based on the decontamination efficiency assigned during the laboratory tests. The periodic inplace testing of the adsorbers to determine the leak-tightness is performed per ANSI/ASME N510 (Reference 3). The activated carbon total bed depth requirement will be 2 inches with a maximum assigned activated carbon decontamination efficiency of 95 percent.

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 13) 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.

9.4.8.2.3 System Operation

Normal Operation

The RWBVS exhaust air fan and room exhaust air fan are started manually. With the exhaust fans running, a building supply air fan is manually started. The supply air fan draws outside air through the preheater and filters the air through medium efficiency particulate filters, either cooling the air with a chilled water cooling coil or heating the air with a hot water heating coil, and distributing the conditioned air throughout the RWB.

The supply air trains are equipped with temperature sensors that control the cooling water flow for the cooling coils, the hot water flow for the preheater and the system heater. The preheater is equipped with a freeze protection temperature sensor, which shuts down supply air fans and closes air inlet dampers if the supply air temperature decreases below a predetermined set point.

The RWBVS exhaust fans are started manually. During normal operation, a system exhaust air fan runs continuously. The standby fans are actuated upon a failure of the running fan, when maintenance is being performed on their respective running fans.

The system exhaust air is drawn through a filter train that consists of a heater, prefilter, HEPA filter, carbon adsorber, post filter, and exhaust air fan. The air is then exhausted to the vent stack. The discharge of the system exhaust fans is monitored for radioactivity. In the event of a high radioactivity level alarm (refer to Table 11.5-1, Monitor R-21), the system can be manually shut down and isolated. To maintain a constant exhaust air flow, the system exhaust air fans work in conjunction with the system exhaust air control damper to adjust for increasing pressure resistance of the filters.

Room exhaust air serves the rooms in RWB that are not normally expected to contain radioactivity. Room air is monitored by the SAMS prior to entering the filtration units. During normal operation, the clean room exhaust air bypasses the filtration units, and the exhaust air is directed to the vent stack. If radioactivity is detected by the SAMS (refer to Section 11.5.3.1.8 and Table 11.5-1, Monitors R-20 and R-22) in any of the rooms served by the room exhaust air system, the contaminated air is automatically rerouted through the iodine filtration unit prior to release to the vent stack. There are two parallel 50 percent filtration units. Each filtration train consists of two motor operated isolation dampers, heater, prefilter, HEPA filter, carbon adsorber, and post filter. The exhaust air is directed through two 50 percent exhaust fans to the vent stack.

Abnormal Operation

The RWBVS is not required to operate during a loss of offsite power (LOOP) or station blackout (SBO) and the RWBVS is not required to operate during or after a design basis accident; therefore the system is provided with no emergency or backup power. A failure in the SHS, OCWS, or the SAMS has no major impact on the RWBVS. A failure in the RWBVS has no impact on the above support systems.

9.4.8.3 Safety Evaluation

The RWBVS is not required for the safe shutdown of the plant or for mitigating the consequences of a design basis accident or a 10 CFR Part 100 event. Therefore, the RWBVS has no safety-related function.

9.4.8.4 Inspection and Testing Requirements

The RWBVS 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.

Initial in-place acceptance testing of the RWBVS is performed as described in Section 14.2 (test abstracts #080 and #203), Initial Plant Test Program, to verify the system is built in accordance with applicable programs and specifications.

The RWBVS 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 RWBVS is performed to demonstrate system and component operability and integrity.

During normal operation, equipment rotation is utilized to reduce and equalize wear on redundant equipment during normal operation.

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 2). Cooling coils are hydrostatically tested and their performance is rated in accordance with the Air Conditioning and Refrigeration Institute (ARI) standards (Reference 12).

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 9), American Society of Mechanical Engineers, ANSI/ASME N510 (Reference 3), ASME AG-1 (Reference 1), and RG 1.140 (Reference 8).

Heaters are tested in accordance with ASME AG-1, Section CA (Reference 1). Carbon filtration units are tested for housing leakage, filter bypass leakage and airflow performance. Periodically and subsequent to each filter or adsorber material replacement, the unit is inspected and tested in-place in accordance with the requirements of RG 1.140 (Reference 8), ANSI/ASME N510 (Reference 3) and ASME AG-1 (Reference 1). The charcoal adsorber samples are tested for efficiency in accordance with RG 1.140 (Reference 8) and ASTM D3803 (Reference 10). Air filtration and adsorption unit 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.

9.4.8.5 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.

The radiation instrumentation requirements for controlling airborne radioactivity releases via the vent stack are addressed in Section 11.5.3.1.8 and Table 11.5-1, monitor/sample points R-20, R-21, R-22, and R-23 and R-24.

All instrumentation provided with the filtration units is as required by RG 1.140.

9.4.8.6 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. NRC Regulatory Guide 1.140, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Normal Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," 2001.

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

10. ASTM D3803-89, "Standard Test Method for Nuclear Grade Activated Carbon," 1989.

11. ANSI/ASME N509-1989, "Nuclear Power Plant Air Cleaning Units and Components," American National Standards Institute/The American Society of Mechanical Engineers, 1989.

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

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

Next File