

## 9.4.8 Radioactive Waste Building Ventilation System

The radioactive waste building ventilation system (RWBVS) provides fresh conditioned air to the Radioactive Waste 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 plant 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 important 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 30 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 dehumidified or filtered, heated and humidified by the supply air system. A humidifier, which provides minimum air humidity, is installed in the common air supply duct of the RWB to treat the supply air. The humidifier is supplied steam from the air humidification system (AHS) to perform its function. If required, electrical air 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 humidifier. Downstream of the humidifier 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, common humidifier, 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, and iodine adsorption charcoal filters. The treated air is then exhausted to the plant 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 rooms in the RWB that are not normally expected to contain radioactivity. Room exhaust air is monitored by the SAMS prior to entering the filter section. The room exhaust air is continuously filtered by five parallel filter trains. Each filter train consists of a prefilter and a HEPA filter. Room exhaust air from these filter trains can be directed to two room exhaust fans or to a filter system consisting of a carbon adsorber and a HEPA filter. Normal operation of the room exhaust air bypasses the carbon adsorber and HEPA filter system. 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 to pass through the iodine filtration system.

The iodine filter unit, installed at the RWB at elevation +36 ft, consists of one air train equipped with two manually operated isolation dampers, one electric heater, one carbon adsorber, one HEPA filter, and two booster fans connected in parallel.

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 ASME N509 (Reference 11) and 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 with a supply air humidifier.

### **System Exhaust Air Handling Units**

Each of the two exhaust air handling units consists of an airtight housing, a prefilter, a HEPA filter, a carbon adsorber, a HEPA 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. Upstream of the two exhaust air handling units in the common duct are electric heaters to maintain proper air inlet temperature to the filtration system.

### **Room Exhaust Air Handling Units**

Each of the five parallel room exhaust air filtration units consists of an air-tight housing, a prefilter, a HEPA filter, and the associated manual dampers. The manual dampers align the filter units to the room exhaust fans or the iodine filtration unit. These parallel air filtration units supply air to two parallel room exhaust fans. The units can also be aligned to a single room exhaust air iodine filtration unit.

### **Room Exhaust Air Iodine Filtration Unit**

The room exhaust air iodine filtration unit consists of an air-tight housing, an electric air inlet heater, a carbon adsorber, a HEPA post-filter, and associated manual air dampers. The manual air dampers reroute air to the two parallel iodine filter booster fans, which supply air to the inlet of the room exhaust air fans.

### **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), ANSI/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 to “close” or “open” position in case of loss of power, depending on the safety function of the dampers. The performance and testing requirements of the dampers are per ASME AG-1 (Reference 1).

### **Electric Heaters**

Electric heaters meet the requirements of 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 high efficiency filters. The prefilters meet the requirements of ANSI/ASHRAE Standard 52.2-1999 (Reference 2).

### **HEPA Filters**

HEPA filters are constructed, qualified and tested in accordance with Reference 1. The periodic in-place testing of HEPA filters to determine the leak-tightness is performed per ASME N510-1989 (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 in-place testing of the adsorbers to determine the leak-tightness is performed per 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 UL 555 (Reference 7) and the damper fire rating is commensurate with the fire rating of the barrier penetrated.

### 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, then humidifying the air through a humidifier and distributing the conditioned air throughout the RWB.

The supply air trains are equipped with temperature and humidity sensors that control the cooling water flow for the cooling coils, the hot water flow for the preheater and the system heater, and steam flow for the humidifier. 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 steam humidifier is controlled by a moisture sensor in the supply air duct.

The RWBVS exhaust fans are started manually. During normal operation, a system exhaust air fan and a room air exhaust fan run continuously. The standby fans are actuated upon a failure of the running fan, when maintenance is being performed on their respective running fans, or if iodine booster fans are required.

The system exhaust air is drawn through a filter train that consists of a prefilter, a HEPA filter, a carbon adsorber, and exhaust air fan. The air is then exhausted to the plant 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.

The room exhaust air, which takes exhaust air from the areas that do not normally contain radioactivity, is monitored for radioactivity concentrations in the air upstream of the room exhaust air filter units. The exhaust air is drawn through five parallel filter trains (four are required for normal operation) by one of the two room exhaust fans. Each of the filter trains consists of a medium efficiency filter and a HEPA filter. The air is then exhausted to the plant stack. The room exhaust air fans work in conjunction with the room exhaust air control damper to adjust for the increasing pressure resistance of the filters to maintain constant air flow. In the event that the monitored radioactivity reaches the high radioactivity alarm setpoint (refer to Table 11.5-1, Monitors R-20 and R-21), the exhaust from the rooms exhibiting radioactivity is manually directed to the iodine filtration unit. The iodine filtration unit consists of a heater, a carbon adsorber, a HEPA post-filter, and one of two booster fans that discharge to the room exhaust air fans and then to the plant 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, AHS, 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, 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), 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 plant 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," ANSI/American Society of Heating, Refrigerating and Air Conditioning Engineers, 1999.
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. UL 555, "Standard for Fire Dampers," Underwriters Laboratories, Sixth Edition, June 1999.
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 D3803-1989, reapproved 1995, "Standard Test Method for Nuclear Grade Activated Carbon," 1989.
11. ASME N509-1989, "Nuclear Power Plant Air Cleaning Units and Components," The American Society of Mechanical Engineers, 1989.
12. ANSI/ARI Standard 410-2001, "Forced-Circulation Air-Cooling and Air-Heating Coils," Air Conditioning and Refrigeration Institute, 2001.