9.4.7 Containment Building Ventilation System

The containment building ventilation system (CBVS) is designed to maintain acceptable ambient conditions inside the Containment Building for proper operation of equipment and instrumentation during normal plant operation and normal shutdown (i.e., outages). The CBVS also provides acceptable ambient conditions for personnel access to the service compartment during normal plant operation, and equipment compartment during outage for conducting inspections, tests and maintenance during normal plant operation.

9.4.7.1 Design Bases

The containment low flow purge exhaust subsystem outside of Containment is designated as a safety-related, Seismic Category I, ESF ventilation system.

This exhaust subsystem serves a safety function when operating in a low flow purge alignment (during power operation) and upon receipt of a containment isolation signal. During the short period of time required to close the containment isolation valves, exhaust air from containment flows through the CBVS purge iodine filtration units and is exhausted to the plant vent stack.

The containment penetration isolation valves are safety related and designed to Seismic Category I requirements. The internal filtration system components are non-safety related but designed to Seismic Category I requirements. The reactor pit cooling fans are non-safety related, but are designed to Seismic Category II requirements. Other CBVS components are non-safety related and Non-Seismic.

The CBVS components are located inside buildings that are designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, and external missiles (GDC 2).

The containment low flow purge exhaust subsystem removes radioactive materials via iodine filtration trains prior to release to the atmosphere (GDC 41). The filtration system is designed to allow periodic inspection (GDC 42).

The internal filtration subsystem filters airborne radioactive materials from the equipment compartments during normal operation.

The containment isolation valves are automatically closed within five seconds upon receipt of a containment isolation signal after receiving a signal from the PACS module, in accordance with BTP 6-4 (Reference 8), to maintain the integrity of the containment boundary and to limit the potential release of radioactive material.

The reactor pit area temperature is maintained less than 150°F under postulated accident conditions to prevent concrete degradation.

The CBVS performs the following safety-related system functions:

- Maintain the component cooling water system's (CCWS) capability to perform its safety related functions by maintaining the integrity of the CCWS's pressure boundary at the two systems' interface. This is a secondary function.

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

- Controls and maintains a negative pressure in the Containment Building when the CBVS purge subsystem is operating.
- Maintains the following ambient conditions in the accessible areas (service compartments) for personnel accessibility and equipment operability during normal operation:
  - A minimum temperature of 59°F.
  - A maximum temperature of 86°F.
  - 30 percent to 70 percent humidity.
- Maintains the following ambient conditions in the non-accessible areas (equipment compartments) for protection and safe operation of the equipment:
  - A minimum temperature of 59°F.
  - A maximum temperature of 122°F.
  - Humidity: Non-condensing.
  - Supports reactor coolant pressure boundary (RCPB) leakage detection.
- Provides an unfiltered vent path from containment to the vent stack during an extended loss of AC power (ELAP) event.

9.4.7.2 System Description

9.4.7.2.1 General Description

The supply air for the containment building ventilation system is conditioned outside air that is filtered, cooled, or heated by the nuclear auxiliary building ventilation system (NABVS) as described in Section 9.4.3. The supply air is delivered to the Containment Building through the Fuel Building plenum. The supply air is then distributed through the CBVS supply duct network if the containment purge subsystem is operating.

The CBVS is composed of the following separate subsystems:

- Containment purge subsystem.

- Internal filtration subsystem.
- Containment Building cooling subsystem.
- Service compartment cooling subsystem.

The containment isolation system is addressed in Section 6.2.4.

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

Containment Purge Subsystem

The containment purge subsystem includes low flow and full flow purge supply and exhaust systems. See Figure 9.4.7-1—Containment Building Low Flow and Full Flow Purge Supply Subsystem and Figure 9.4.7-2—Containment Building Low Flow and Full Flow Purge Exhaust Subsystem.

The containment low flow purge subsystem is normally not in operation during the plant normal operation. However, the low flow purge subsystem can be used during normal operation and outage conditions. The containment full flow purge subsystem is used during plant outages. The supply side ducts receive air from NABVS (refer to Section 9.4.3) through the Fuel Building (FB) concrete plenum. The supply air is then directed through the containment annulus penetration ducts into the containment plenum which discharges air into the service compartments of the Containment Building. The service compartments include technical rooms, instrument rooms, staircases, tank rooms, annular space at the operating floor, and annular space at the lower level. With the purge subsystem in operation, the air from the service compartments flows into equipment compartments as a result of pressure differential.

The low flow purge exhaust subsystem contains two redundant filtration trains located in the FB. Radiation monitors are located upstream of the filtration trains for monitoring the containment exhaust air prior to filtration (refer to Section 11.5.3.1.4 and Table 11.5-1, Monitors R-7 and R-8). The filtration trains receive air from the exhaust duct of the low flow purge exhaust subsystems. During a fuel handling accident in the RB, the full flow and low flow purge supply and the full flow purge exhaust containment isolation valves are closed, and low flow purge exhaust is filtered through the low flow purge exhaust subsystem filtration trains. The CBVS low flow purge exhaust can also be directed to the safeguard building controlled-area ventilation system (SBVS) iodine filtration trains in an emergency for redundancy (refer to Section 9.4.5). Each filtration train consists of a moisture separator, electric heater, prefilter, HEPA filter, carbon adsorber, post filter, and exhaust fan. The exhaust air from the filtration trains is directed to the plant vent stack. The radiation monitor located downstream of the CBVS low flow purge iodine filtration trains monitors and records the release of radioactive contaminants to the vent stack (refer to

Section 11.5.3.1.4 and Table 11.5-1, Monitor R-9). The full flow purge exhaust subsystem directs the containment exhaust air through the NABVS exhaust filtration train (refer to Section 9.4.3).

The dampers downstream of the supply plenum regulate pressure inside the Containment Building. The equipment compartment exhaust dampers regulate differential pressure between the service and equipment compartments when the low flow purge subsystem is operating.

The containment purge subsystems provide automatic isolation of containment atmosphere by quick closure of containment isolation valves and closure of the air supply in front of the hatch.

The containment purge subsystem is designed in accordance with ASME AG-1 (Reference 1) and RG 1.52 for atmospheric cleanup.

The low flow purge exhaust duct provides a vent path from the containment to the vent stack through a bypass vent path around the ESF filters and fans for use during an ELAP event.

Internal Filtration Subsystem

The internal filtration subsystem (See Figure 9.4.7-3—Containment Building Internal Filtration Subsystem) limits the release of radioactive material by reducing radioactive iodine contamination inside the equipment compartment with air circulation and filtration during normal plant operation. The internal filtration subsystem contains one filtration train which consists of an electric heater, prefilter, HEPA filter, carbon adsorber, and post filter; with two redundant fans downstream of the filtration train. The air is drawn from the equipment compartments, filtered, and returned to the equipment compartments.

Radiation monitors are located upstream of the filtration trains for monitoring the radiation in the equipment compartments prior to filtration (refer to Section 11.5.3.1.5 and Table 11.5-1, Monitor R-10).

The system is designed in accordance with ASME AG-1 (Reference 1) and RG 1.140 (Reference 14).

Containment Building Cooling Subsystem

The containment building cooling subsystem (See Figure 9.4.7-4—Containment Building Cooling Subsystem) provides cool air into a stainless steel sheet metal circular header located above the residual heat removal-safety injection room, and into the reactor pit cooling fan plenum. The containment building cooling subsystem provides cool air to the reactor coolant pumps, steam generators, chemical volume control system (CVCS), control rod drive mechanism system (CRDMS), and vent and drain system. There are two trains of two main fans and four cooling coils located in the equipment compartments. The cooling coils receive cold water from the operational chilled water system (OCWS).

Two trains of two reactor pit cooling fans located in the equipment compartments supply cool air to the reactor pit area. These fans are used to ventilate the reactor pit during normal and station blackout (SBO) conditions. The reactor pit is cooled by air from a plenum between the main fans and the reactor pit cooling fans. The supply air subsystem to the reactor pit is composed of a 16 duct layout around the main coolant piping.

The exhaust from these areas is recycled through the cooling coils located in the equipment compartments.

The system is designed in accordance with ASME AG-1 (Reference 1).

Service Compartments Cooling Subsystem

The service compartment cooling subsystem (See Figure 9.4.7-5—Containment Building Service Compartments Cooling Subsystem) contains 12 recirculating cooling units. Each air cooling unit is equipped with a cooling coil connected to the OCWS. The recirculation cooling units provide ventilation and cooling for the service compartments. The service compartments include safety injection system valve rooms, steam generator blowdown system tank and heat exchanger rooms, instrument measuring cabinets and table rooms, and containment dome and annular space.

The system is designed in accordance with ASME AG-1 (Reference 1).

9.4.7.2.2 Component Description

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

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 AG-1 (Reference 1).

The low flow purge exhaust duct from the CI valves through the filter bypass duct and to the vent stack is designed for a pressure of 35 psig and a temperature of 280°F.

Moisture Separators

The moisture separator meets the requirements of RG 1.52 (Reference 12), ANSI/ASME N509 (Reference 15), and ASME AG-1 (Reference 1). The moisture separator is located upstream of the filter air heater and the prefilter to protect the HEPA filter and carbon adsorber from potentially high humidity level by removing the entrained water droplets from the inlet air stream. The moisture separator design shall be qualified by testing in accordance with the procedure described in ANSI/ASME N509.

Filter Air Heaters

The filter air heaters are located upstream of iodine filters to prevent excessive moisture accumulation in the carbon adsorbers. The heaters are constructed and tested in accordance with ASME AG-1 (Reference 1).

Prefilters

The prefilters are located upstream of HEPA filters and collect large particles to increase the useful life of the HEPA filters. The prefilters are designed in accordance with 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 per ANSI/ASME N510 (Reference 3).

Adsorbers

Carbon adsorbers are used to remove radioactive iodine from the exhaust air. The efficiency for removing methyl iodine is based on the decontamination efficiency assigned during the laboratory tests. The periodic in-place testing of adsorbers to determine the leak-tightness is performed per ANSI/ASME N510 (Reference 3).

Post Filters

The post filter is located downstream of the carbon adsorber. During operation of the carbon filtration exhaust, the air flow rate will be low through the carbon adsorber to prevent spread of the carbon dust. However, the post filter ensures that carbon dust or carbon fines are removed prior to the air being distributed further. The post filter meets the requirements of ASME AG-1 (Reference 1), and has an average atmospheric dust efficiency of 95% in accordance with ANSI/ASHRAE Standard 52.2 (Reference 2). The post filter is equipped with differential pressure measurement which indicates the degree of particulate loading and the need for filter change.

Fans

The supply and exhaust fans are centrifugal or vane-axial designed with electric 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 startup testing to establish accurate air flow balance between rooms. The motor-operated isolation dampers will fail as-is in case of power loss. The performance and testing requirements of the dampers will be conducted 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 17) 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.

A combination fire and smoke damper is required in the containment vent path. The damper has a temperature override option. This allows normal closure of the damper assembly at 165°F and the ability to override the 165°F closure command and remain open provided the temperature does not exceed 350°F.

Recirculation Cooling Units

The recirculation cooling units consist of a fan section, a water cooling section, and a moisture separator. The housing is constructed of heavy gauge steel. The fan is driven by an electric motor. The cooling coils are finned coil type and are connected to the operational chilled water system. The cooling coils are designed in accordance with ASME AG-1 (Reference 1 and Reference 18). The moisture separator collects condensate which is directed to drain system.

9.4.7.2.3 System Operation

Normal Plant Operation

The containment low flow purge subsystem can operate during normal operation. The containment building negative pressure is maintained by controlling the supply air flow through the motorized dampers. The internal filtration subsystem equipment compartment is isolated unless airborne radioactivity contamination is detected (refer to Section 11.5.3.1.5 and Table 11.5-1, Monitor R-10) and personnel access is required in the service compartment. When the low flow purge subsystem is in operation, a negative pressure is maintained between the equipment and service compartments.

The containment air exhaust stream is monitored for gaseous activity prior to filtration by effluent radiation monitors (refer to Section 11.5.3.1.5 and Table 11.5-1, Monitors R-7 and R-8). Downstream of the low-flow purge iodine filtration trains, the exhaust is again monitored for contaminants prior to release by monitoring point R-9.

When the reactor is in cold shutdown, ventilation in the Containment Building is provided by both low flow and full flow purge subsystems. The negative pressure in containment is regulated by the supply air flow of both low flow and full flow purge subsystems.

The internal filtration subsystem is in operation during plant operation to detect activity level in the building, and air flow purges the equipment compartment in a recirculation mode (refer to Section 11.5.3.1.5 and Table 11.5-1, Monitor R-10). This system is not required during outages since there are no fission products being produced.

The containment building cooling subsystem operates during normal and shutdown conditions to remove heat generated in the equipment compartments. This system operates continuously to maintain ambient conditions in the equipment compartments. If the supply air temperature downstream of fans is 82°F or higher, the cooling coils provide cool air.

The service compartment cooling subsystem also operates during normal and shutdown conditions to maintain acceptable room temperatures in the service compartments.

Abnormal Operating Conditions

The containment isolation valves located on the low flow and full flow purge supply and exhaust ducts automatically close when a containment isolation signal is initiated. In the event of loss of the internal filtration subsystem, the exhaust air can be filtered through the containment low flow purge exhaust subsystem prior to release to the vent stack.

In the event of loss of the chilled water system, the component cooling water system (CCWS) provides a water supply to the cooling coils.

In the event of failure of the containment building cooling subsystem fans, the fresh air to the annular space and the operating floor and equipment compartment can be supplied by the full flow purge subsystem in conjunction with a reconfiguration of the dampers.

Loss of Ultimate Heat Sink

In case of loss of ultimate heat sink (LUHS) or the loss of CCWS, the cooling fans in the Containment Building are kept in operation to avoid localized areas of high temperature.

Loss of Offsite Power

Alternate onsite power sources provide power to the valves to close in time to achieve safety functions in case of a loss of offsite power. The dampers on the internal filtration subsystem and containment building cooling subsystem fail to the "as-is" position. The power supply to main fans and reactor pit cooling fans is supplied from corresponding emergency diesel generators. Air cooling unit fans stop in the service compartment cooling subsystem.

Fuel Handling Accident in the Containment Building

In the event of a fuel handling accident in the Containment Building, the containment isolation valves for the full flow and low flow purge supply and the full flow purge exhaust can be manually closed by pushing the emergency push button located in the fuel handling area inside the Containment Building. The KLA supply air damper to the equipment hatch area and the KLL exhaust damper at the emergency airlock are closed. The low flow purge exhaust subsystem is used to avoid the spread of contamination by keeping a negative pressure in the Containment Building and filtering the exhaust through the low flow purge exhaust subsystem iodine filtration trains (refer to Section 9.4.5, Section 11.5.3.1.4, and Table 11.5-1, Monitors R-7, R-8, R-9). The SBVS iodine filtration trains can be used as backup.

High Pressure Level or Safety Injection Signal

In case of high-pressure level or a safety injection signal, the containment penetration valves on the containment purge subsystem are closed and air flow in the Containment Building is stopped.

Station Blackout

In the event of an SBO, the reactor pit area is air cooled to prevent degradation of the concrete structure. The reactor pit cooling fans take air from the supply air shaft. The air is supplied to the bottom of the pit and transferred through openings in the pit wall around the main coolant piping to maintain a temperature less than 150°F. The power supply to the reactor pit cooling fans is provided by the SBO diesel generators.

Small-Break Loss-of-Coolant Accident and Loss-of-Coolant Accident

In the event of a small-break loss-of-coolant accident (SBLOCA) or loss-of-coolant accident (LOCA), containment isolation valves automatically close after receipt of the containment isolation signal. These valves are designed to perform their isolation function under LOCA conditions and will close within five seconds after receipt of a containment isolation signal from the PACS module.

ELAP

In the event of a loss of all AC power, the low flow purge exhaust duct may be used to vent the containment. Compressed air is provided to the CI valves to allow them to open. A bypass duct around the ESF filters and fans is used to direct the containment air to the vent stack.

9.4.7.3 Safety Evaluation

The CBVS maintains proper temperatures in the Containment Building during normal operations and shutdown conditions. Sufficient redundancy is included for proper operation of the system when one active component is out of service. The CBVS is an engineered safety feature and the safety-related functions are closure of the CBVS containment isolation valves (CIV) and filtration of the low flow purge prior to closure of the CIVs during a postulated rod ejection accident.

The CBVS low flow purge removes radioactive materials via two 100 percent iodine filtration trains prior to release to the plant vent stack. Each train operates independently. A failure in one train will not prevent the remaining train from providing the required engineered safety feature function.

The containment purge subsystem supply and exhaust penetrations through the containment annulus are equipped with two normally open isolation valves, each connected to separate control trains. A failure in one train will not prevent the remaining isolation valve from providing the required capability. The valves automatically close within five seconds after receipt of a containment isolation signal from the PACS module. The isolation valves and containment penetrations are the only portions of the CBVS that are safety related.

The four main cooling coils enable the CCWS's capability to perform its safety related functions by maintaining the integrity of the pressure boundary of the CCWS's cooling supply and return lines. This is a secondary design function.

9.4.7.4 Inspection and Testing Requirements

The CBVS 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 CBVS is performed as described in Section 14.2 (test abstracts #073 and #203), Initial Plant Test Program, to verify the system is built in accordance with applicable programs and specifications.

The CBVS 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 CBVS 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.

Per IEEE 334 (Reference 9), type tests of continuous duty class 1E motors for CBVS are conducted to ensure ESF system operation and availability.

Fans and air handling units 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 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), American Society of Mechanical Engineers, ANSI/ASME N510 (Reference 3), ASME AG-1 (Reference 1), and RG 1.52 (Reference 12).

Emergency filtration units are tested by manufacturer 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 1.52 (Reference 12), ANSI/ASME N510 (Reference 3) and ASME AG-1 (Reference 1). The charcoal adsorber samples are tested for efficiency in accordance with RG 1.52 (Reference 12) and ASTM D3803 (Reference 13). Air filtration and adsorption unit heaters are tested in accordance with ANSI/ASME N510 (Reference 3).

Internal 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 14), 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 14) and ASTM D3803 (Reference 13). 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.

In-service test program requirements are described per Ventilation Filter Test Program (VFTP) in Chapter 16, "Technical Specification" Section 5.5.10. ESF filtration unit testing will be completed at least once every 24 months.

9.4.7.4.1 Preoperational Tests

Refer to Section 14.2 (test abstracts #073, #075, #076, and #203) for initial plant startup test program. Initial in-place acceptance testing of CBVS components will be performed in accordance with ASME AG-1 (Reference 1), ANSI/ASME N510 (Reference 3), and RG 1.52 (Reference 12).

9.4.7.5 Instrumentation Requirements

Indication of the operational status of the equipment, position of dampers, instrument indications and alarms are provided in the main control room (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 minimum instrumentation, indication and alarms for CBVS ESF filter system are provided in Table 9.4.7-1 per the requirements of ANSI/ASME N509 (Reference 15).

The radiation instrumentation requirements for controlling airborne radioactivity releases via the vent stack are addressed in Sections 11.5.3.1.4, 11.5.3.1.5, Section 11.5.4.8, and Table 11.5-1, Monitors R-7, R-8, R-9 (Low Purge Subsystem), and R-10 (Internal Filtration Subsystem).

9.4.7.6 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. NUREG-0800, BTP 6-4, Revision 3, "Containment Purging During Normal Plant Operations," U.S. Nuclear Regulatory Commission, March 2007.

9. IEEE 334-1974, "IEEE Standard for Type Tests of Continuous-Duty Class 1E Motors for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 1974.

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.

12. Regulatory Guide 1.52, Revision 3, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants", U.S. Nuclear Regulatory Commission, June 2001.

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

14. 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", U.S. Nuclear Regulatory Commission, June 2001.

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

16. Deleted.

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

18. ASME Boiler and Pressure Vessel Code, Section III, Division 1, “Rules for Construction of Nuclear Facility Components,” The American Society of Mechanical Engineers, 2004 Edition.

Table 9.4.7-1—Minimum Instrumentation, Indication and Alarm Features for CBVS (Low Flow Purge Exhaust Subsystem)

Sensing Location	Local Indication / Alarm	MCR Indication / Alarm
Electric Heater Inlet	Temperature Indication	
Electric Heater	Status Indication	Status Indication
Electric Heater Outlet	Temperature Indication	Temperature Indication / High Temperature Alarm
Prefilter	Pressure Drop Indication / High Alarm	
HEPA	Pressure Drop Indication / High Alarm	
Adsorber	Pressure Drop Indication / High Alarm	
Adsorber Outlet	Temperature Indication	Temperature Indication / High Temperature Alarm
Post Filter	Pressure Drop Indication / High Alarm	
System Filters Inlet to Outlet		Summation of pressure drop across entire filtration train (Indication / High Pressure Drop Alarm)
Fan	Pressure Drop Indication	Handswitch / Status Indication
Damper / Operator	Position Indication	Position Indication
Unit Outlet	Flow Rate Indication	Flow Rate (recorded indication, high alarm signal)
Unit Outlet	Radiation Indication	Radiation Indication / High Radiation Alarm

Next File