9.4.3 Nuclear Auxiliary Building Ventilation System

The nuclear auxiliary building ventilation system (NABVS) provides conditioned air to the Nuclear Auxiliary Building (NAB) to maintain acceptable ambient conditions, to permit personnel access, and to control the concentration of airborne radioactive material during normal operations and anticipated occupational occurrences. The system also provides conditioned air to the Fuel Building (FB), Containment Building, and the annulus area between the Containment Building and the Shield Building.

The exhaust air from the NAB, FB, Safeguard Building (SB), Containment Building, and the annulus is processed through the NABVS filtration trains prior to release to the environment via the plant stack.

9.4.3.1 Design Basis

All components of the NABVS are non-safety related and Non-Seismic, as specified in Section 3.2.

- The NABVS meets GDC-2 for all components as it relates to meeting the seismic design criteria based on the guidance of RG 1.29 Position C.2 (GDC-2).
- The NABVS has no shared systems or components with other nuclear power units (GDC-5).
- The NABVS meets GDC-60, as it relates to the ability of the system to limit release of gaseous radioactive effluents to the environment. The NABVS exhaust iodine filtration trains meet the guidance of RG 1.140 Positions C.2 and C.3. RG 1.52 is not applicable because the NABVS is not required to operate during post-accident engineered safety features (ESF) atmospheric cleanup. The air flow rate of a single cleanup filtration unit will not exceed 30,000 cfm.

The NABVS performs no safety-related functions and the system is not required to operate during a design basis accident.

The NABVS performs the following important non-safety-related system functions:

- Controls and maintains a negative pressure within the NAB relative to the outside environment.
- Maintains the following temperature and humidity ranges for the areas serviced:

  A. Minimum temperature 50°F.

  B. Maximum temperature 113°F.

  C. Humidity 25 to 70 percent.

9.4.3.2 System Description

9.4.3.2.1 General Description

The NABVS is divided into the following subsystems:

- Supply air.
- NAB air supply.
- Exhaust air.

Supply Air Subsystem

The outside-conditioned air is supplied through a set of redundant filter trains consisting of HEPA filters, humidifiers, heating coils, and cooling coils. See Figure 9.4.3-1—Nuclear Auxiliary Building Supply Air Filtration and A/C Trains. The conditioned supply air maintains ambient conditions in the areas served by this system within prescribed limits for operation of equipment, and personnel safety and comfort. The NABVS provides conditioned air to the following areas:

- NABVS air distribution supply air shafts and ductwork.
- Containment building ventilation system (refer to Section 9.4.7).
- Fuel building ventilation system (refer to Section 9.4.2).
- Annulus ventilation system (refer to Section 6.2.3).

The outside air is provided through intake mesh grills and louver dampers. The outside air intake openings are equipped with electrically heated and weather protected grills to prevent ice formation and ingress of insects and debris. The intakes are designed to provide adequate outside air to meet the distribution requirements of supply air under design conditions of the plant.

The air intake plenum supplies air through three filtration trains. Each train consists of a preheater, prefilter, cooling coil, heater, silencer, humidifier, and air dampers. Four supply air fans take suction from the supply fan inlet plenum and supply air to the outlet air shaft for further distribution to the supply shafts of different buildings.

The design supply air flow to serve the NAB, FB, annulus ventilation system, and Containment Building would require all three trains to be in operation. However, during normal operation, a reduced air flow rate can be used that requires only one supply train to be in operation.

Nuclear Auxiliary Building Air Supply Subsystem

This subsystem supplies air to the NAB to maintain ambient conditions within the prescribed limits for equipment operation and personnel access. See Figure 9.4.3-2—Nuclear Auxiliary Building Air Supply and Exhaust Subsystem.

The conditioned air is supplied to all levels of the building through air shaft cells and a duct distribution network. The flow rate to each room is calculated based on the room volume and equipment heat loads to maintain ambient conditions. The normal operation of the system is to maintain a negative pressure in the building with respect to the outside atmosphere to prevent leakage of potentially contaminated air to the environment. The air flow paths within the NAB are designed so that if radiation is detected, migration of contaminated air from areas of potentially high radioactivity to areas of potentially low radioactivity is limited.

The recirculation cooling units are provided for the rooms with high heat loads. Cooling coil units with fans provide recycled cooled air to the rooms where vapor compressors, electrical switchgear, and transformers are located.

Exhaust Air Subsystem

This subsystem processes exhaust air through filtration trains and charcoal filtration trains to limit airborne radioactivity released through the plant stack. See Figure 9.4.3-3—Nuclear Auxiliary Building Exhaust Filtration Trains Subsystem.

The system processes air exhaust from the following areas:

- FB Cell 5 exhaust (refer to Section 9.4.2).
- FB Cell 4 exhaust (refer to Section 9.4.2).
- NAB Cell 3 exhaust, including annulus exhaust.
- NAB Cell 2 exhaust.
- NAB Cell 1 exhaust.
- SB Cell 6 exhaust (refer to Section 9.4.5).
- Containment Building full flow purge exhaust (refer to Section 9.4.7).

The filtration trains to process exhaust air from the above areas are located inside the NAB. Each filter train consists of a prefilter and a HEPA filter. Under normal operating conditions, these flow paths open into a common exhaust plenum. Four exhaust fans take suction from this plenum and discharge into another exhaust plenum which directs the exhaust air to the plant stack for an elevated release.

If high radiation is detected in any of the rooms within the NAB, Reactor Building (RB), FB, or SBs, the NABVS exhaust is diverted to an iodine filtration plenum. It is then directed to one of the four redundant independent iodine filtration units. Each iodine filtration unit includes fire dampers, preheater, iodine adsorber using activated carbon, HEPA filters, dampers, and a booster fan. The exhaust air from the booster fan is directed to the exhaust plenum for discharge through the plant stack. See Figure 9.4.3-4—Nuclear Auxiliary Building Exhaust Iodine Filtration Train Subsystem.

The NABVS also has two iodine filtration train units and fans to serve the laboratory exhaust air. Each laboratory iodine filtration train unit includes preheater, HEPA filters, iodine adsorber, fire dampers, motor-operated dampers, and booster fans. The exhaust air from the booster fans is directed to the exhaust plenum for discharge through the plant stack. See Figure 9.4.3-5—Nuclear Auxiliary Building Laboratory Iodine Exhaust Filtration Train.

9.4.3.2.2 Component Description

The major components of the NABVS are listed below, along with the applicable code and standards. Refer to Section 3.2 for the seismic and system quality group classification of these components.

Ductwork and Accessories

The supply and exhaust air ducts are constructed of galvanized sheet steel and are structurally designed for fan shutoff pressures. The ductwork meets the design, testing and construction requirements per ASME AG-1-2003 (Reference 1).

Heaters

Supply air trains have hot water heaters. The heater design is based on the minimum outside air design temperature and supply air temperature requirements. The coils are constructed and tested in accordance with Reference 1. Electric heaters are located upstream of iodine filters to prevent excessive moisture accumulation in the charcoal beds.

Humidifiers

Humidifiers add moisture to the supply air as needed to maintain acceptable ambient conditions. The design of humidifiers is based on the outside air design conditions and supply air humidity requirements.

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 will 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 filters 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.

Fans

The supply and exhaust fans are centrifugal or vane-axial design with electrical motor drivers. Fan performance is rated in accordance with ANSI/AMCA-210-99 (Reference 4), ANSI/AMCA-211-1987 (Reference 5) and ANSI/AMCA-300-1985 (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 Reference 1.

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.

Recirculation Units

The recirculation units are comprised of chilled water cooling coils and fans, which are designed to process and supply cool air for the compressor, switchgear and transformer rooms.

9.4.3.2.3 System Operation

Normal Plant Operation

Under normal plant operation, the NABVS continuously draws, conditions, and supplies outside air to maintain the required ambient conditions in various rooms of the NAB, FB, annulus, and low-flow purge ventilation of the Containment Building. Two of the four supply fans are able to provide the required air flow during normal plant operation.

The NABVS exhausts sufficient air to maintain a negative pressure inside the NAB relative to the outside environment. The exhaust air from the NAB, FB, SB, and Containment Building is processed through a dedicated filtration train to a common exhaust plenum, and subsequently directed by two of the four exhaust fans to the plant stack.

The laboratory exhaust is processed through one of the two iodine filtration trains, with one of two exhaust fans operating, prior to its discharge through the plant stack.

All system fire dampers are in the open position.

When the plant is in cold shutdown, the NABVS operates in combination with the containment building ventilation system to purge the containment service compartments. The exhaust is processed through a specific NABVS exhaust train.

Abnormal Operating Conditions

Failure of Iodine Adsorber Train

Failure of a fan in an operating iodine adsorber train initiates the operation of another iodine train; thus, the single failure has no effect on the functioning of the system. For the laboratory exhaust system, two filter trains are provided; in the event of a failure in one of the trains, the other train will start automatically.

Iodine Activity Detection

In the event iodine is detected in the NAB, FB, or SB, the affected exhaust flow paths are redirected through the iodine filtration train prior to discharge through the plant stack. Iodine activity is detected separately in each cell.

Fuel Handling Accident in the Fuel Building

In the event of a fuel handling accident in the FB, the FB exhaust and supply are isolated by closing the appropriate dampers (refer to Section 9.4.2). To prevent spread of airborne contamination, the iodine filtration trains of the SB ventilation system process the exhaust air to maintain the required pressure in the FB pool hall (refer to

Section 9.4.5). The remainder of the FB is ventilated by the NABVS. During and after the fuel handling accident, proper NABVS supply and exhaust flow rates are maintained by adjusting the control dampers.

Fuel Handling Accident in the Containment Building

In the event of a fuel handling accident in the Containment Building, the containment isolation valves close (refer to Section 9.4.7). Exhaust from the Containment Building is routed to the iodine filtration trains of the SB ventilation system. Excess air supply from the NABVS is redirected by adjusting the supply air control dampers.

Operation of Safety Injection System during LOCA

In the event of a loss of coolant accident (LOCA), leakages in the safety injection system (SIS) can lead to iodine activity levels that are above the limits of the NABVS iodine filtration trains. In such a case, the SB exhaust is routed through the SB ventilation system (refer to Section 9.4.5). Excess air supply from NABVS is redirected by adjusting the supply air control damper. The NABVS supply and exhaust to the FB are isolated (refer to Section 9.4.2).

Loss of Offsite Power (LOOP)

Upon loss of offsite power, the isolation dampers fail to the closed position, preventing any pathway for potentially contaminated air to leak out to the environment.

Station Blackout (SBO)

In the event of SBO, there will be no power to any of the electrical components of the NABVS. Isolation dampers with spring return will fail to the closed position. Other isolation dampers will fail “as-is”.

9.4.3.3 Safety Evaluation

None of the components of the NABVS perform a nuclear safety-related function. The NABVS components are not required to operate during a design basis accident (DBA). In case of a DBA, the NABVS is isolated from the HVAC systems of other buildings by isolation dampers.

The NABVS provides adequate capacity and redundant trains to maintain proper temperature levels in the NAB, FB, Containment Building, and annulus.

9.4.3.4 Inspection and Testing Requirements

Refer to Section 14.2 (test abstracts #079 and #203) for initial plant startup test program. Initial in-place acceptance testing of NABVS components will be performed in accordance with Reference 1 and Reference 3.

9.4.3.5 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.

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

9.4.3.6 References

1. ASME AG-1-2003, "Code on Nuclear Air and Gas Treatment," The American Society of Mechanical Engineers, 2003 (including the AG-1a, 2004 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," Underwriter's Laboratories, Sixth Edition, June 1999.

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